THE THEORY OF CONSUMER DEMAND:

A CRITICAL APPRAISAL

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by

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Being an Inquiry into the

Possible Existence of a

Testable Theory of

Consumer Behavior.

Preface

This essay is not a treatise on classical theories of consumer behavior. Instead it is an inquiry into the possible existence of an empirically testable theory of consumer demand. The inquiry begins with an examination of currently received theory and ends with the outline of a proposed theory of consumer decision-making behavior. My object, then, is clear: it is to discover whether it is possible to construct a micro economic theory of consumer demand that can be submitted to a series of empirical tests. Since theories that are not empirically testable cannot be employed to generate empirically significant predictions, the motivation for this study is equally clear. It is provided by a desire to explain and predict consumer behavior.

It is a pleasure to acknowledge my indebtedness to Professors C. G. Hempel and H. A. Simon. While the extent of my debt is partially apparent from my references to their published work, I particularly wish to express my thanks to Professor Hempel for his many helpful comments and criticisms.

Finally, I should like to thank the Social Science Research Council for making it possible for me, under a Post-Doctoral Fellowship, to spend a year in the Department of Philosophy at Princeton University studying the problems posed in this essay.

G. P. E. C.
Cambridge, Massachusetts
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INTRODUCTION

The history of economic thought is in part a history of a dispute
over the criteria to be employed when adjudging the validity of economic
theories. This debate, like many others, has tended to confuse as well
as clarify many of the relevant issues. And, like most other debates
there is a central piece of data which ~~no one likes but is difficult~~ is neither easy to approve of nor to
ignore. Consequently, it is the desire to dispose of or accommodate the
awkward data that stimulates and prolongs the polemics. In the economic
debate the datum is provided by the unpleasant, but often noted, fact
that the predictive powers of economic theory are strikingly weak when
compared with those of the physical sciences. Economists have responded
to this irritant by developing and employing a set of criteria that largely
ignore this lack of predictive success. As a result economic theories are
normally judged on the basis of criteria such as, consistency with accepted
doctrine, and ability to be deduced from standard premises, all of which
avoid any direct reference to empirical phenomena. This is not to say
that economists are not interested in developing theories which explain
and predict the course of economic events. But rather that the notable
poverty of predictive success has led them to adopt other criteria by
which to appraise and reject contending theories.

If a theory is to be judged by alternative sets of criteria, then
the choice of criteria can be expected to influence the way in which the
theory is constructed. If consistency with accepted doctrine is the chief
criterion, then one can readily predict that new theories will not be

proposed that violate this constraint. Therefore, it is pertinent to inquire whether it is the criteria themselves, or the nature of the subject matter that has led economic theory into this unfortunate state of affairs. Both the existence and the intensity of the debate might lead one to suppose that most economists preferred the former to the latter answer to this question.[1] But this does not in fact appear to be the case. Instead many economists have argued that the absence of good predictions is due to the fact that economic theory, by its very nature, differs from the type of theory found in the physical sciences. In particular it is frequently asserted that the problems of developing and testing economic theory are essentially different from those encountered in the physical sciences. And many ingenious, and at times impressive arguments have been proposed in support of this claim.[2]

However, it is our opinion that this position is mistaken. And that it is the criteria and not the subject matter that are at fault. Thus, it is the principal purpose of this essay to demonstrate that the source

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1/ A recent example of this dispute, with references to some of its history, can be found in the Southern Economic Journal Vol. XXII, July, 1955, in the paper by F. Machlup, "The Problem of Verification in Economics," pp. 1-21, the reply by T. W. Hutchison, "Professor Machlup on Verification in Economics," and Machlup's "Rejoinder to a Reluctant Ultra-Empiricist," pp. 476-493.

2/ An excellent review of the forms this argument has taken can be found in: S. Schoeffler, The Failures of Economics: A Diagnostic Study, Harvard University Press, 1955, Ch.2.

of the affliction lies within the theories of economics themselves and not within the nature of the subject matter.

To suggest that the theories of economics are defective is to suggest that they have been constructed in a manner that does not permit success-ful predictions to be generated from them. Even though this may appear to be an obvious statement of the case, it clearly implies that economic theories must be unable to meet the standards normally applied to physical theories. In other words, if physical theories can be used to predict the course of physical events, then the criteria employed by physicists must differ from those employed by economists. If these two sets of criteria do in fact differ, then the observation that economic theory is not a part of empirical science would be sufficient to account for the notable lack of success economists have had in predicting the course of economic events. Yet to observe that economic theories do not belong within the pale of empirical science does not imply that they must forever remain in this state. On the contrary, to arrive at this conclusion is to provide the necessary first step along whatever program of revision and reform is required. To recognize the etiology of a disease is the first essential step towards prescribing a cure.

While we have no desire to belittle the difficulty of constructing theories that can successfully predict economic events, we are unable to accept the position that it is not possible to do so. Hence, the first

part of this essay is devoted to securing our position by demonstrating the existence of this necessary first step. That is to say, we shall endeavor to establish and defend the following proposition: that the absence of successful predictions is due to the fact that the theories of economics are unable to meet the normal requirements employed in empirical science.

Unfortunately, the classes of economic theory are both many and disparate. Hence, it is beyond the scope of one essay to establish the validity of this proposition for all economic theories. Even to begin to substantiate this proposition will require us to restrict our attention to a single class of theories. But, to select one theory for extensive examination might be construed as being unnecessarily arbitrary. Critics could rightfully protest that whatever might be true for one specific theory need not be true for the remainder of economic theory. In order to circumvent the somewhat arbitrary nature of any choice we shall base our selection on one of the avowed objectives of economics itself--namely, that the purpose of economics is to describe and predict the behavior of economic man. Accordingly we have taken as the subject of our investigation the micro-economic theory of consumer behavior. From this decision, it follows that in the first part of this paper we shall essay to establish the following propositions:

(i)   that it is not possible to employ the micro-economic

theory of consumer behavior (the theory of demand) to

generate empirically significant predictions about consumer

behavior.

(ii)   that this predictive void is due to the fact that the

theory of demand is unable to meet the normal requirements

employed in empirical science.

To pose these propositions in this manner may appear to suggest

that normative questions, historically of greater concern to economists,

are of lesser importance. While we have no desire to disparage either the

importance or the success economists have had in developing and

applying some normative theories, it is the positive (or descriptive)

theories that provide the scientific basis for policy prescriptions.

If some positive theories cannot be empirically confirmed, then it

must follow that their normative counterparts have no scientific foundation.

And that such policy prescriptions as are derived from them are devoid

of empirical relevance. Admittedly this is by no means the first time

it has been suggested that some of the principal theories of economics

cannot be corroborated by empirical test.[3] But the implications of this

assertion are sufficiently serious to warrant a searching examination of

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3/   For examples of other authors who have asserted that the theories of
economics are largely devoid of empirical content see: T. W. Hutchison,
The Significance and Basic Postulates of Economic Theory, Macmillan.
and Company, London, 1938; and A. G. Papandreou, Economics as a Science,
Lippincott Co., New York, 1958.

the truth of this claim. Thus, as we have already noted, our primary task
shall be to examine the cogency of this claim. And, so that we may by
implication include as large part of economic theory as is possible at one
time, we have selected as the subject of our investigation the basic theory
of micro-economics--namely, the theory of consumer demand.

In the normal course of events it may not occur to economists to
question the empirical validity of their principal theories. But, once
the question has been raised and their validity challenged it is not
sufficient merely to ascertain whether these theories can meet one set
of criteria or not. After all, it can be readily argued that there are
many ways in which a given body of theory may be used, as well as many
different sets of criteria by which a particular theoretical construction
may be judged. Therefore, before we can begin our investigation we must
in some sense justify the criteria that we are going to employ.

As noted above the motivation for this study is provided by a desire
to demonstrate that the lack of predictability in economic theories does
not stem from any inherent difficulties in the subject matter itself.
But rather that it arises from the fact that the theories of economics
have failed to meet the standards governing empirical science. We are
clearly assuming, therefore, that it is highly desirable that economic
theories, whether they currently do meet these standards or not, should
be constructed so that they can be accepted as a part of empirical science.

From the discussion of this point in the literature it appears that many economists do not agree with this position. But, the acceptance of this goal implies that the criteria by which we should judge the theory of demand are those which are generally accepted as the criteria for the demarcation of empirical science.

Although we have no desire to compete with philosophers of science, both the reader as well as the author must be agreed, for the purposes of this study, on the uses and meanings of the terms that are employed. Thus, even though economists almost invariably disapprove of methodological discussions, allowances must be made if we are to describe the analytical tools we shall employ.

To those who share our basic views our proposed investigation of part of micro-economic theory is perhaps a laudable task by itself. But, the notable lack of predictive success this body of theory has encountered would *prima facie* tend to indicate that it would not meet the criteria governing empirical science. Thus, to carry out this indagation only to conclude that the theory of demand does not meet the same standards that are met by some physical theories would not appear, by itself, to be a particularly significant contribution to our knowledge. What would be important, however, is to use this analysis to discover the ways in which these two types of theories differ. And, as a result, to isolate and identify those factors that have kept economics from becoming a part of science.

To point out the stumbling blocks, however, is only to expose oneself to the greatest temptation of all--namely, the immodest desire to suggest a possible solution to the dilemma. Once the quarry has been identified and the first signs of a trail have been exposed it is very difficult not to press on. Thus, the second half of this essay is devoted to the task of proposing a solution to this predicament. In brief, we shall outline one possible way in which the theory of demand can be rescued from beyond the pale of empirical science and turned into a testable theory of consumer behavior. In doing so we shall take pains to outline and support each step of our proposed solution with such evidence as we can muster. But, it should be understood that we are not suggesting that our approach to the resolution of the difficulty is the only possible one. For, if one solution can be discovered then presumably other and more effective ways of achieving the same results can also be discovered. Nevertheless, before more effective and elegant procedures can be developed a solution must be proposed and worked out. And it is in this spirit that the second half of this essay is written.

The purpose of this study then is not to increase by one the number of articles and books written on the problems of verification in economics. Rather our object is of a much more positive kind. Our goal is to refute the proposition that the development and testing of economic theory is essentially different from that encountered in the physical sciences by proposing and demonstrating the validity of the following two propositions:

(i) That the problems of developing and testing micro-economic theory need be no different from those encountered in the physical sciences.

(ii) That it is possible to develop a body of micro-economic theory having the same explanatory and predictive power as is enjoyed by the physical sciences.

Thus, while this essay will only be concerned with the theory of demand we are suggesting that the implications of our analysis apply to the entire body of micro-economic theory.

Organization of the Essay

As we mentioned earlier, the history of economic thought is replete with discussions on the criteria that should be employed when judging the validity of economic theory. Since we are proposing that economics should be judged by the standards employed in empirical science it is necessary to define and describe what these standards entail. Hence, the next chapter is devoted to a discussion of some of the fundamental terms and analytical tools that we employ in the following chapters. Before we can begin our analysis, however, we must be agreed upon the content of the theory that we are going to examine. Consequently, in Chapter III we present the essential parts of the theory of demand as it is currently received. So that our analysis may proceed in an orderly fashion our first concern is to examine the concepts of the theory so that we can identify their sources of empirical content. This analysis is presented in Chapter IV. We then turn in Chapter V to an investigation of the

function of the theory's postulates and laws in the explanation and predic-
tion of an economic event. In Chapter VI we present the results of our

investigation and isolate and identify what we have taken the liberty of

calling the "economists dilemma." Having reached our necessary first

step, Chapters VII and VIII are then devoted to outlining what we consider

to be both a possible and a practical solution to the problem of developing

an empirically testable theory of demand. The last chapter contains a

summary of what we have set out to accomplish and the conclusions that

the results appear to warrant.

CHAPTER II

SOME NOTES ON SCIENTIFIC DEDUCTIVE SYSTEMS

"Empirical science, in all its major branches, seeks not only to describe the phenomena in the world of our experience, but also to explain or understand their occurrences: it is concerned not just with the 'What?', 'When?', and 'Where?', but definitely and predominantly with the 'Why?' of the phenomena it investigates."[1]

From this definition it appears that not every theory we might see fit to construct to "explain" a particular set of observations would be classified as belonging to the body of empirical science. Some of our theories, e.g. theories about the behavior of historical personages, might only contain a description of the events under consideration. In this case there would be an implicit understanding that we would be able to "explain" the occurrence of a new event if the description of this further event coincided with the description in our theory. On the other hand we might have constructed a general theory which appeared to "fit" or "explain" a large number of individual cases, e.g. a regression line drawn through a particular sample of data, but from which we could not with any assurance of success predict the "What?", "When?" or "Where?" of the next relevant case. Somehow the theories of empirical science are supposed to combine all of these elements. And it is the purpose of this

[1] Carl G. Hempel, "The Logic of Functional Analysis," in L. Gross (ed.) Symposium on Sociological Theory, Row, Peterson and Company, New York, 1959, p. 271.

chapter to examine some of the basic criteria a theory must meet if it is
to be classified as belonging to the corpus of empirical science.

1. Theories as Deductive Systems

From this brief discussion it is apparent that one of the main functions
of a scientific theory is to "explain" the "Why?" of the phenomena it in-
vestigates. It is also evident that to be able to answer the "Why?" of
an event is not perhaps as easy as it may appear. One of the conditions
that must be met is that the phenomena to be "explained" must be inferable
from the theoretical structure. That is to say, the occurrence of the
event to be "explained" must be deducible as a direct consequence from
the concatenation of the theory and some initial conditions. For this
condition to be met the theoretical system must conform to the general
rules of logic that govern the formation and manipulation of deductive
systems. Thus, in order to examine the nature of a scientific theory we
must first examine some of the principal characteristics of deductive systems.

A. Deductive Systems as a Calculus

Everyone who has ever had to learn some simple mathematics or
geometry knows that the essence of a deductive system consists in a process
of deriving a desired set of propositions (frequently called theorems)
from a given, initial set of propositions (frequently called axioms). The
derivation of the desired proposition is achieved by following a set of
rules that enables us to derive a variety of new propositions from the

original set. And by a repeated application of the same rules we eventually arrive at a statement of the desired proposition. While the content of these propositions may pertain to any body of knowledge whatsoever it is the formal structure of the deductive system--that is, the set of rules-- that we are concerned with here.

In order to examine the properties of a deductive system we need to have a technique of representing and classifying the set of rules or deductive principles. Fortunately, logicians have provided us with the required analytical tools. Within this analytic framework deductive principles are represented by a set of symbolic rules which govern the manipulation of abstract symbols. A particular collection of these symbolic rules is called a calculus. Accordingly, we can distinguish a deductive system from the calculus that represents its formal structure in the following way: An inquiry into the properties of a calculus belongs to what is called syntax or syntactics; while an inquiry into the relation between a calculus and the deductive system it represents belongs to semantics.[2] Since it is usually easier and sometimes more fruitful to give examples of a concept rather than to rigorously define it, we shall only dwell briefly on the formal properties of a calculus before providing an example.

2/ For a more detailed discussion of these concepts and terms see: R. Carnap, "Foundations of Logic and Mathematics," _International Encyclopedia of Unified Science_, University of Chicago Press, Vol. I, No. 3, 1939.

A calculus, considered by itself, is a set of rules that allows an operator to manipulate a given set of symbols in such a way that he can transform one series of symbols into another. The symbols themselves may belong to a particular language, like English or mathematics, or they may merely be a collection of uninterpreted marks on a piece of paper. What distinguishes a calculus from a particular set of deductive principles written, say, in the English language is that the rules of the calculus specify how the manipulations are to be carried out without making any reference to the "meaning" of the symbols themselves. For this reason a calculus can be viewed as a symbolic game in which each move of the game is governed by the specified rules.

The components of a calculus can now be specified as follows: The vocabulary is defined by making a list of the symbols that are to be used. These symbols are the <u>primitive symbols</u> of the calculus and may represent, in a manner to be discussed later on, the components of a deductive system. Primitive symbols can be strung together into sequences in a variety of ways. Any finite sequence of these symbols is called a formula. But since we are usually only interested in dealing with formulas that have specified properties, a set of rules is required that will determine which are the permissible or <u>well-formed formulas</u>. Therefore, a calculus must contain a set of formation rules as well as a set of primitive symbols.

Before we can begin to manipulate symbols and formulas we must have somewhere to start from. In a calculus the initial position is determined

by selecting a specific set of well-formed formulas. These formulas are identified as the axioms for the system, and are accepted as the basic formulas of the calculus game.

In order to employ these axioms to generate new formulas we need to have some rules of play. In a calculus these rules are provided by a set of _rules_ _of_ _inference_. Rules of inference (or rules of procedure) specify the types of manipulation that are to be allowed. By applying these rules to the axioms we can infer or generate other well-formed formulas. And, if we have as the object of our manipulations the derivation of a particular formula, we can employ the rules of inference to see whether this particular formula can be inferred from the axioms we have selected. It should be noted that there is nothing within the rules of the calculus itself to guarantee that we can infer a particular well-formed formula from a given set of axioms. On the contrary, the choice of a particular sequence of inferences, just like a choice of a particular sequence of moves in a game, is up to the player. The calculus merely specifies the procedures by which the formulas are to be inferred.

Once a particular well-formed formula has been arrived at by a specific sequence of inferences from one or more of the axioms, this sequence of formulas is called a _proof_ of the last formula in the sequence. And once a proof has been discovered for a particular formula this formula is usually called a theorem to distinguish it from other well-formed formulas for which no proof has yet been constructed.

So far our calculus contains primitive symbols, formation rules, axioms, rules of inference, and a definition of what constitutes a proof. If there were no further requirements that we needed to impose it is clear that we could construct a calculus in an infinite variety of ways. We would be free to choose our symbols, rules of formation, and rules of inference in any manner we thought to be convenient at the time. To do so, however, might lead us to build systems of calculi in which proofs could be established for self-contradictory and other inappropriate types of formulas. In order to prevent the occurrence of contradictory formulas a calculus is required to meet the condition of consistency. And once we have a consistent system the only other requirements that need to be met are that the calculus should be complete and its axioms independent. Although these concepts are too complex to be discussed here in any detail their properties can be roughly characterized as follows: A consistent calculus is one in which not every well formed formula is a theorem. In the case where the calculus includes the notion of negation, this notion implies that a calculus is inconsistent if a specific well-formed formula and its negation are both provable within the system. The concept of completeness, on the other hand, requires that every well-formed formula or its negation be a theorem of the system. That is to say, if a calculus is complete, and if a well formed formula which is not a theorem is added to the sytem, this addition would make the calculus inconsistent. And finally, the independence requirement is met if it can be shown that the axioms of a calculus cannot be infered one from another.

As a result, the axioms of a calculus are independent if it can be shown
that be deleting one of them, then the remaining axioms are not sufficient
to establish a proof of the one that was deleted.

Having provided a brief discussion of the properties of a calculus
we shall now examine an example of such a system so that we may then
proceed to demonstrate how this analytical tool can be used to investigate
the properties of scienfific theories. The example we shall use is taken
from the class of calculi known as the propositional or sentential calculus.
Before we can go on to the example we must first make clear the distinction
between the language that is under examination, the object language,
and the language we use to talk about the object language , the metalanguage.

The need for this distinction should be readily apparent. For
example, a student taking a course in physics deals with the language of
physics as his object language and employs his spoken language, English
in this instance, as his metalanguage. The physical symbols of the
object language have no meaning until they are interpreted by means of
the metalanguage. However, once the symbols in the object language have
been assigned a meaning, then the physical theory has become a deductive
system with which the student can now make meaningful manipulations.

In our example, therefore, the calculus consists of two kinds of
marks. The first are a series of capital letters, e.g. 'A', 'B', 'C', 'D',
whose number can be expanded by the use of subscripts, e.g. 'A_1', 'B_1',
'C_1', 'D_1', 'A_2','B_2', 'C_2', 'D_2',...The second kind consists of four

marks '$\sim$', '$\supset$', '((', and '))'. All of these symbols belong to the object language of this calculus, and if we are to be able to talk about these marks in a metalanguage we need to have some names for them. Hence, in our metalanguage the name of a capital letter will be given by the same letter italicised, e.g. the name of 'A' is '$\underline{A}$', the name of 'B' is '$\underline{B}$', etc. Also the names of the other four marks, '$\sim$', '$\supset$', '))', '((' are '$\sim$', '$\rightarrow$', ')', '(' respectively.

Now the letters 'A', 'B', 'C', 'D' are formulas or statements in the object language. And if we are to be able to talk in the metalanguage about the formulas of the object language we need one further set of marks. These marks in the metalanguage are '$\underline{P}$', '$\underline{Q}$', '$\underline{R}$', '$\underline{S}$'. They are called <u>variables</u> and may be used in the metalanguage to denote any well-formed formula in the object language.

Therefore, if the formation rules are such that $\underline{P}, \sim\underline{P}, \underline{P} \rightarrow \underline{Q}$, $\sim\underline{P} \rightarrow \sim\underline{Q}$, and $\sim(\underline{P} \rightarrow \underline{Q})$[3] are all well-formed formuls it is easy to see how we can begin to construct statements or formulas in the metalanguage. In order to carry out some manipulations with these formulas we employ two rules of inference. The first, called <u>modus ponens</u>, states that if we are given the formula $\underline{P}$ and the formula $\underline{P} \rightarrow \underline{Q}$, then we can infer the formula $\underline{Q}$. Hence, the rule of <u>modus ponens</u> allows us to draw the conclusion $\underline{Q}$

<u>3</u>/ Throughout the remainder of the essay the single quotation marks ' ' will be omitted; and the reader is requested either to imagine that they are there, or to supply them himself.

from the major premiss $P \rightarrow Q$ and the minor premiss P. The second rule,

called the rule of substitution, permits us to substitute one variable

for another within a formula as long as this substitution is carried

out for each occurrence of the variable in question. For example, if we

were given the formular $P \rightarrow Q$ this rule allows us to substitute R for P

and S for Q and get the formula $R \rightarrow S$. Hence, if we were given the formula

$P \rightarrow (Q \rightarrow P)$, as an axiom, and were asked to construct a proof of the

formula $S \rightarrow (R \rightarrow S)$, we could proceed in the following way. We would

note that if we substituted S for P and R for Q that we could apply

the rule of substitution and immediately arrive at the formula $S \rightarrow (R \rightarrow S)$.

Thus, the proof would consist of a single application of the substitution

rule. If we now wanted to write down a proof for the formula $(R \rightarrow S)$ we

would previously need to be able to construct a proof for S. That is to

say, since we already have a proof for $S \rightarrow (R \rightarrow S)$, if we could construct

a proof for S, then by the rule of modus ponens we could infer $(R \rightarrow S)$.

To be able to continue to develop proofs for various formulas in this

calculus we would need to have an independent set of axioms and make sure

that our system was both consistent and complete. However, we are only

interested in presenting the calculus as a tool for analyzing deductive

systems. Accordingly we shall not develop our example any further.[4]

Instead we shall now examine the problem of interpreting these systems.

B. Interpreting the Calculus

Up to now we have presented the calculus as a system that consists

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4/ This system of propositional calculus is presented in its entirety in:
A. Church, Introduction to Mathematical Logic, Princeton University Press,
1956, Vol. 1, Ch. II.

of symbols, formation rules, and rules of inference or manipulation.
Before we can apply our calculus to a particular context, we need to have
some rules whereby we can interpret the meaning of the symbols as well
as of the well-formed formulas of which these symbols are a part. Not
the meaning
only do we need to know what the particular symbols represent but we also
need to be able to tell what it is that is being asserted by any
particular statement or formula. In short we need an effective procedure
for determining the meaning of the well-formed formulas that can be
generated within a deductive system. Before we can examine the meaning
of the formulas, however, we need to assign an interpretation to the
statements in our calculus. In this case we shall let A, B, C, D be the
names of statements in the calculus. And the calculus will be supposed
to be composed of English sentences. Hence, P, Q, R, S, which are
variables in the metalanguage, will denote any of the English sentences
contained in the calculus. So as to simplify the analysis as much as
possible these statements will be restricted to being simple sentences
sush as 'this wire is made of copper' and 'this wire conducts electricity'.
To complete this interpretation we need to give a meaning to the two
connectives $\rightarrow$ and $\sim$. That is to say, we need to have a procedure for
determining exactly what is being asserted by the statement 'this wire is
make of copper' $\rightarrow$ 'this wire conducts electricity'. In order to understand
what is being asserted by such a statement we need to introduce the notion
of a 'truth value'. To each statement like 'this wire is made of copper'
we can assign a truth value--that is, the statement either has the value
'true' or 'false'. Consequently, if we have two such statements and link

them together by the connective $\rightarrow$, e.g. 'this wire is made of copper' $\rightarrow$
'this wire conducts electricity', then we will know what is being asserted
by this statement if we know the conditions under which the expression
has the value 'true' and those under which its value is 'false'. The
solution to this problem is provided by what are called truth tables.
Truth tables specify the truth value for a statement for the different
combinations of truth values of its component parts. For example, the
truth table for ' $\rightarrow$ ' is given by table (i) while the truth table for ' $\sim$ '
is given by table (ii).

Table (i)

P	Q	P $\rightarrow$ Q
T	T	T
T	F	F
F	T	T
F	F	T

Table (ii)

P	$\sim$ P
T	F
F	T

From tables (i) and (ii) it is apparent that we have made the
symbol ' $\rightarrow$ ' correspond to the English words 'if...then' or 'implies',
and the symbol ' $\sim$ ' correspond to the English word 'not'. Also from
table (i) we can see that if we know the value of P is 'true' and that of
Q is 'false', then the value of the statement P $\rightarrow$ Q is 'false'. Indeed,
it should be noted that this is the only set of truth values that will
give the value 'false' to the proposition P $\rightarrow$ Q. Clearly we can also use
this table to find out the truth value of the formula we took as an axiom

for our recent example--namely, $P \rightarrow (Q \rightarrow P)$. In this case we find that
no matter what values we ascribe to P and Q the value of the formula is
always 'true'. For example, let the value of P be 'false' and that of
Q be 'true'. To derive the truth value of the whole statement we first
consider the part within the brackets, i.e. $(Q \rightarrow P)$. From the table we
conclude that its value is 'false'. Hence, the values of P and $(Q \rightarrow P)$
are both 'false'. And it follows that the value of $P \rightarrow (Q \rightarrow P)$ is 'true'.
In a similar manner we could compute the value of this relation for the
other values of P and Q. A few calculations will quickly show that the
value of $P \rightarrow (Q \rightarrow P)$ is always 'true'. Thus, we can conclude that the
truth value of this expression is independent of the truth value of its
component parts. If the truth value of a statement is independent of the
truth value of its component parts then its value must depend on the
truth value given to it by its logical connectives. Statements of this
sort are called tautologies, and are described as being logically true--
that is, their value is 'true' independent of the values ascribed to their
individual parts.

If all the statements in our deductive system are tautologies then
it is called a "pure"[5] deductive system. But, not all deductive systems
are pure deductive systems. And the procedure for determining the truth
value of a particular statement differs depending on whether the deductive
system can be classified as being pure or not. As we have seen, in a

5/ The terms "pure" and "applied" are taken from R. B. Braithwaite,
   Scientific Explanation, Cambridge University Press, 1953, p.34.

pure deductive system the truth value of both the initial and of the inferred statements depends solely upon their logical connectives. In the case of an applied deductive system, the truth value of a sentence does not depend solely upon the truth value of its logical connectives. Instead, the truth value of the sentence depends upon whether its component parts are suitably supported by the available empirical evidence. Since empirical science is composed of various types of applied deductive systems, the following sections are devoted to examining the problems that arise in determining the truth values of the statements that appear in these systems.

2. Empirical Science and the Criterion of Falsification

In the previous sections we noted that a deductive system could be characterized by its underlying calculus. While both the pure and the applied deductive systems are alike in this respect, they differ in the procedures that are used to establish the truth value of their respective propositions. Since empirical science can be characterized as an applied deductive system, a procedure that establishes the truth value of a relation in an applied system must also be a procedure that determines the truth values of propositions in empirical science. Thus, our examination of the truth values of an applied deductive system is also an examination of the way in which truth values can be established for the postulates and hypotheses of an empirical science.

In order to present this analysis in an orderly fashion as possible we shall first take up the problem of determining the truth value for a simple contingent proposition,[6] whose component parts depend for their truth values upon the available empirical evidence.

To carry out this analysis we shall make use of the following example: In the previous section we saw that the variables P, Q, R, S could represent English sentences. Also that the proposition P·→ Q could represent the statement: If 'this wire is made of copper' then 'this wire conducts electricity'. Now suppose for the moment that we are anxious to find out whether this statement is "empirically true".[7] Before we can answer this question we must first know what data are required to confirm this hypothesis. And to answer this question we must return for a moment to the truth tables to examine the conditions under which this hypothesis can be confirmed.

From the truth tables we observe that if the antecedent clause "this wire is made of copper' has the value 'true', then the value of the expression

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6/ For a more detailed examination of the roles of contingent propositions in deductive systems see: R. B. Braithwaite, op. cit. pp. 34 ff.

7/ In the remainder of this essay the term "empirically true" will be considered equivalent to the term "empirically confirmed". By these terms we mean that the available evidence supports the hypothesized expression. This by no means implies that the expression has somehow been empirically "proved". On the contrary, the best that can be said is that the evidence does not contradict the hypothesis. Thus, in all cases where these terms are used we will be using them as an abbreviation for the statement, "the evidence has not yet disconfirmed the expression."

will depend on the truth value of the consequent 'this wire conducts electricity'. In all the remaining cases. e.g. when the value of the antecedent is 'false', the truth value of the expression is 'true' whether the consequent has the value 'true' or not. Hence, if we wish to confirm the expression, we must first know whether the antecedent is supported or not by the empirical evidence. If the evidence does not support the statement 'this wire is made of copper', then we cannot submit the expression to an empirical test. On the other hand, if we have data that supports the statement 'this wire is made of copper' then the expression $P \rightarrow Q$ will be confirmed if we can find empirical support for the consequent Q. Consequently, the only way we can tell whether $P \rightarrow Q$ is empirically true is to observe both that 'this wire is made of copper' and that 'this wire conducts electricity'. In this case we can state that the expression has been empirically confirmed.

However, if we had stated this expression in a more general form-- namely, 'all wires that are made of copper conduct electricity'--then it is clear that while confirming instances can still be found we shall never be able to tell whether this expression will always be supported by the data. Thus the minute we extend the singular statement $P \rightarrow Q$ into the general statement 'all instances of P are also instances of Q' it follows that we can no longer hope to be able to completely determine its truth value. Instead we can only determine for each set of observations whether the statement has been confirmed or not.

The problem of determining the truth value of an expression becomes even more involved if we introduce into our applied deductive systems propositions that contain one or more terms for which no empirical evidence can be directly gathered, i.e. non-observational terms. Under these conditions it is no longer possible to determine whether the expression has been confirmed or not. For example, let the variable P represent the statement A which in turn contains a term that is not definable in observational terms. And let Q represent the statement B whose terms are all observationally defined. Then, if we wish to determine whether the statement $P \rightarrow Q$ is empirically true it does not help us to be able to tell that statement Q is supported by the empirical evidence. For whenever the value of Q is 'true' the value of the expression $P \rightarrow Q$ is also 'true' even though the statement P may be 'false'. Accordingly, if it is not possible to empirically determine the truth value of P it is not possible to submit $P \rightarrow Q$ to a direct empirical test. As a result, the inclusion of non-observational concepts in the propositions of applied deductive systems makes it even more difficult to determine their empirical truth value.

Empirical science, however, is concerned with developing bodies of theory that are empirically testable. And the theories of empirical science frequently contain non-observational concepts or terms e.g. electrons, protons, atoms, etc. Hence, it follows that we cannot expect to be able to find direct supporting evidence for all the terms in all the expressions

of which a particular theory is composed. As a result, we can conclude

that it is not always possible to directly confirm a particular theory

and we must search for another criteria if we wish to be able to separate

testable from non-testable theories.

Since it is not always possible to directly confirm a given body of

theory a solution to this dilemma can be reached by approaching the

problem from the opposite direction. In particular a criterion of

falsification can be employed.[8] This criterion states that a theory can

be accepted as a part of empirical science if and only if it is possible

to refute or disconfirm it by empirical test. But a theory can only be

refuted if it asserts the existence of a set of data or expressions

which contain observational terms. Thus, this criterion distinguishes

between theories that do and theories that do not have empirically

testable implications. And it only classifies the former as belonging

to empirical science.

From our previous analysis it should be apparent that to be able to

disconfirm a single hypothesis one must know that the value of the

antecedent is 'true'. For example, to be able to disconfirm the

hypothesis if 'this wire is made of copper' then 'this wire conducts electricity'

8/ The criterion of falsifiability was developed by Karl Popper who
    asserts that a theory is a part of science if and only if it is
    possible to subject the theory to a process of refutation by empirical
    test. For an extensive discussion of this criterion see: Karl R. Popper,
    The Logic of Scientific Discovery, Basic Books, New York, 1959.

we must first observe that the wire is made of copper before it is fruitful
to examine whether the wire conducts electricity. If we cannot find out
empirically whether the wire is made of copper then it is not possible
to refute the expression $P \Rightarrow Q$. Thus, if we employ the falsifiability
criterion a theory is not considered to be a part of empirical science
unless it is possible to refute it by the appropriate empirical test.

To accept this criterion, however, does not dispose of the question
of how to determine the empirical truth value of hypotheses that contain
non-observational or theoretical terms. Some theorists have strongly
urged that all such hypothesis should be restated so that they only
contain observational terms[9]. But, such a position would seriously
undermine a number of very important theoretical structures. Hence,
if we do not agree to dispose of all non-observational terms, then we
need a set of procedures that enable us to determine whether such a theory
can be considered to be empirically testable.

In practice this problem is resolved by requiring a theory to provide
some deduced hypotheses that are themselves capable of being refuted by

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9/ This methodological position, entitled "operationism," was first
advanced by P. W. Bridgman in The Logic of Modern Physics, Macmillan, New
York, 1927. For an excellent survey of the adequecy and applicability
of this technique see: "Symposium on Operationism," Psychological
Review, Vol. 52, Sept., 1955, especially the contribution by H. Feigl,
"Operationism and Scientific Method," pp. 250-259. For a more recent
analysis of the problems posed by the operationist's approach see:
Carl G. Hempel, "The Theoretician's Dilemma," Minnesota Studies in
the Philosophy of Science, University of Minnesota, 1958, Vol. II, pp. 37-98.

empirical test. In other words if a theory is to be considered to be
empirically testable it must be possible to deduce from it a set of
expressions that only contain observational terms. If this is not the
case--that is, if it is not possible to deduce from the theory a set of
expressions that are refutable by empirical test--then there is no way
of determining the empirical truth value of the theory. Hence, we do
not have an effective procedure for ensuring that a body of theory has
been empirically confirmed. But the application of the criterion of
falsifiability does provide us with a set of procedures with which it is
possible to determine whether the truth value of a given body of theory
can be subjected to a series of empirical tests.[10]

Conclusions

At the beginning of this chapter we noted that the principal
objective of empirical science is to "explain" the "Why?" of the
phenomena it investigates. Although an examination of what is meant by
the term "explain" is left until later in this essay,[11] we have been
concerned with an examination of the basic structure of a scientific theory.
In our discussion we noted that a deductive system can be represented by
a calculus which in turn must be interpreted if it is to represent an
applied or an empirical deductive system. It was also noted, that it was

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10/ This issue is discussed in much greater detail by Carl G. Hempel,
  Problems and Changes in the Empiricist Criterion of Meaning," Revue
  Internationale de Philosophie, Vol. 11, 1950. (Reprinted in L. Linsky
  (ed), Semantics and the Philosophy of Language, University of Illinois Press,

11/ See Chapter V.

necessary to have a decision rule with which to determine the truth value
of the formulas or statements contained in the system. While an effective
procedure was described for determining the logical truth value of the
given statement, a number of problems were encountered when we tried to
establish an effective procedure for determining their empirical truth
value. Consequently, we have adopted a set of procedures that do not
guarantee the empirical truth value of a given body of theory. Instead
they only permit us to determine whether it is possible to test for its
empirical truth value.

Because we do not have an effective procedure for determining the
truth value of a particular theory we cannot hope to be able to decide,
for example, whether the theory of demand is empirically true or not.
The best that we shall be able to do is to inspect the theory to see
whether it is possible to submit it to a process of refutation by
empirical test.

Before we can ascertain whether it is possible to subject a particular
theory to a process of refutation by empirical test we must first examine
the concepts and terms employed in that theory. In our previous analysis
we observed that if the concepts of a set of expressions are non-
observational--that is, have no direct empirical content--then it is not
possible to directly submit these expressions to empirical tests. Thus,
if all the concepts of a deductive system are devoid of empirical content,
then it is not possible to submit the theoretical structure to an empirical

test. Although a theory is seldom entirely devoid of empirical content, we shall first examine the theory of demand to determine the sources and the extent of the empirical content of its concepts and terms.

Having examined the concepts and terms we shall then inspect the posutlates and hypotheses to see whether any or all of them can be submitted to a process of refutation by empirical test. If some of the concepts have sufficient empirical content so that some of the hypotheses contain testable statements then it is possible to submit at least part of the theory to empirical test. The theory must then be considered a part of empirical science. However, if the theory does not contain any hypotheses that can be subjected to empirical test, then it follows that the theory cannot be considered a part of empirical science. Consequently, when we examine the hypothesized relations in the theory of demand our principal concern shall be to decide whether these relations have sufficient empirical interpretation to allow their truth values to be determined by the appropriate empirical test.

In order to carry out this investigation we need to have before us the concepts and statements of which the theory of demand is composed. In spite of the large number of books and articles that have been written on the theory of demand there are a sufficient number of differences in these presentations to leave in doubt precisely how the theory is to be interpreted. Hence, our presentation will be greatly facilitated if we can agree, for the purposes of this essay, on the essential components of this theory. Therefore, even though the reader is undoubtedly familiar with at least one formulation of this theory the next chapter will be

devoted to an explication of what we consider to be a reasonable consensus of its more important elements.

CHAPTER III

THE THEORY OF DEMAND

This chapter is concerned with the parts of the theory of consumer
behavior that pertain to the micro-economic theory of demand. As a result
the discussion will center upon the two types of theories that in our
opinion best characterize its current state of development. Our approach,
however, makes no attempt at being exhaustive. Rather, we intend to
include only as much of the current theory as is suited to the purpose
at hand.

The theory of demand is a theory about the behavior of consumers in
the market place. Its purpose is to explain the process by which consumers
make choices from among the alternative commodities available to them at
any one point in time. The consumer in this theory is an entity whose
object is to maximize the satisfaction he can derive from selecting the
best possible combination of commodities he can afford. Originally, it
was postulated that the consumer was able to measure the comparative
utilities of alternative bundles of commodities on a cardinal utility scale.
So that with the inclusion of a principle of diminishing marginal utility
it was possible to identify the particular collection of commodities
that would yield the highest utility. Hence, by incorporating into
the theory the postulates of a cardinal utility function and a principle
of diminishing marginal utility it was possible to show that for any given

consumer there was a unique collection of commodities which maximized his satisfaction or utility. From this result it was then shown that a further piece of theory could be constructed from which the Law of Demand could be directly deduced--namely, that a rise (fall) in the price of an article would decrease (increase) the amount purchased, other things being held constant.

Current theories,[1] however, have dropped both of these restrictive postulates. It was discovered that the essential conclusions could be deduced from much weaker postulates about behavior. Whatever theory one deals with though, it must be remembered that the Law of Demand is one of the principal conclusions that must be reached if the theory is to be accepted as a possible explanation of consumer's behavior. Since there are several theories of consumer behavior, and since we are going to examine two only of them here, it is well to remember that it is the Law of Demand toward which each theory is directed. Because this is one important conclusion all the theories have in common, we shall present each theory in its form as an explanation of the Law of Demand. Consequently, we shall pay somewhat less attention to some of the other conclusions that are also derivable from them. Also, because these theories differ both in their basic postulates and in their points of departure, we shall begin with an examination of the utility maximizing

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1/ For an excellent survey of current theories of consumer behavior See: J. M. Henderson and R. E. Quandt, Microeconomic Theory, McGraw-Hill, New York, 1958, Ch. 2 and the references cited therein.

approach and consider the theory of revealed preference later.

1. Utility Analysis

One of the fundamental notions connected with these explanations of consumer behavior is the concept of utility. Early economists such as Jevons, Walras, and Marshall postulated that the consumer was capable of assigning to each commodity or combination of commodities a number that represented in cardinal terms the amount of utility associated with that selection of goods. It was also postulated that the consumer was aware of all possible alternatives. And further, that after he had assigned particular utilities to each of the alternatives he would then select the combination which yielded him the highest utility. As noted above, it was also postulated that as additional units of the same commodity were consumed the utility derived from this extra consumption would diminish. This is the famous principle of diminishing marginal utility. And from these postulates it could be deduced that the consumer would increase his purchases of commodities, subject to his budget constraints, up to the point where there no longer was a net gain in utility. It was a brief step to deduce from these results that a fall in the price of a commodity would increase the quantity purchased, other things remaining the same. Accordingly the law of demand with its various properties had been successfully derived.

Current theory, however, has abandoned the postulate of cardinal utility

and has replaced it by an ordinal utility function. In this case it is postulated that the consumer can rank order the alternatives that are presented to him in terms of his preferences. This ranking of preferences does not imply that the consumer can state how much more he prefers A to B, but rather only that he does prefer A to B. However, before these preferences can be represented by a utility function the conditions of three further postulates must be met. The first is that for all possible pairs of alternatives X and Y the consumer must be able to say whether he prefers X to Y, Y to X, or whether he is indifferent between them. The second postulate requires the consumer to be able to make up his mind about all these alternatives so that only one of the three possibilities is true for any pair of alternatives. The third postulate is even more restrictive in that it requires the consumer to be consistent in his allocation of preferences--namely, if he prefers X to Y and Y to Z, then he must prefer X to Z. This condition of transitivity must apply to all possible pairs of alternatives.

A The Utility Function

Because the theory of utility is designed to provide us with a foundation for the law of demand, the utility function is defined in terms of a consumer's purchases during a specified period of time. There is no unique time interval over which the utility function should be defined. But a time period is usually chosen such that the consumer has sufficient time to derive utility from purchasing a wide variety commodities. Whatever

period is chosen, however, it must be remembered that the utility

function is defined with respect to consumption only during that particular

time interval. To be able to extend the analysis over longer intervals

the consumer is postulated to repeat his analysis and calculations at the

beginning of each period.

From this brief discussion we can now move on to consider some of the

properties of the utility function. We shall proceed in the normal manner

by starting with the simple case where the consumer's purchases are

limited to two commodities. The utility function can then be represented by:

$$U = f(x, m)$$

where x and m are the quantities purchased by the consumer of the two

commodities X and M. In other words the utility derived from the purchase

of a specific quantity of X and M is given by the point (x,m). And the locus

of all such combinations of X and M that yield the same level of utility

is represented by the function $U = f(x,m)$.

If X and M represent two particular commodities, such as apples and

potatoes, this simplified case appears to be unnecessarily restrictive.

But if we allow X to represent one commodity, say apples, and M to repre-

sent a composite commodity that includes all other commodities,[2] then

the simplified case no longer appears to be quite so restrictive. However,

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2/ The composite commodity is defined here in a Hicksian sense--that is, it
   includes all other commodities including savings so that the total amount
   spent on X and M represents the consumer's total income for the period.
   The only way the total income cannot be spent within a given time period
   is by a physical destruction of parts of M before it has been spent. This
   type of action is specifically ruled out.

by letting the second commodity, M, stand for a composite commodity we do not have as close an approximation to reality as we might have at first thought, since there are two further properties of the utility function which we have not yet pointed out. First of all it is postulated that the utility function is continuous--i.e., there are an infinitely large number of combinations of X and M that lie along the utility surface. This postulate implies that if we were only considering apples and potatoes, then both commodities would have to be divisible into indefinitely small parts. The second postulate is that the utility function has continuous first and second order partial derivatives--i.e., the utility function is postulated to represent a smooth, unbroken curve. Thus, if we consider once again the case where X and M represent apples and potatoes, then these two postulates imply that it is reasonable to consider the case where a consumer is deliberating whether to select another tiny slice of apple or a further morsel of potato. But, by substituting a composite commodity for M, which could be represented by money, the situation is less difficult to imagine. For M can now be divided into relatively small parts with respect to X. Thus, although the postulates of a continuous utility function with continuous first and second order partial derivatives still imply complete divisibility of the two commodities, a suitable interpretation of these commodities can be employed to serve as a rough approximation in the simplified case under consideration.

Now a particular level of utility, say Uo, can be derived from a
large variety of combinations of X and M. That this is so can readily
be seen from the properties of the utility function just discussed. In
principle, since $U = f(x, m)$ is continuous, there are an infinite number
of combinations of X and M that will yield a certain amount of utility,
say Uo. Further it is postulated that for a given amount of income the
consumer will prefer combinations of commodities that yield greater than
less utility. As a result, it is also a consequence of these postulates
that the consumer is indifferent between different combinations of goods
that yield the same utility. Therefore, it follows that the consumer is,
in principle, indifferent between the large variety of combinations of X
and M that will yield the one level of utility given by Uo. The locus
of points made by these combinations produces a curve known as the
Indifference Curve. Hence, each indifference curve represents a particular
level of utility. So that if a combination of X and M, given by (x_1, m_1)
represents a level of utility U_1 which is greater than Uo, then the
indifference curve representing U_1 will be placed above the curve
representing Uo. Similarly indifference curves that represent a level of
utility lower than Uo will be placed beneath Uo. For example, in
Figure 1 if we let point B = Uo, then by the way the indifference curves
are placed we can conclude the level of utility represented by point C is
greater than that of A. In other words, if all other factors remain the
same, the consumer would want to consume at the level given by C rather
than at the levels given by B or A.
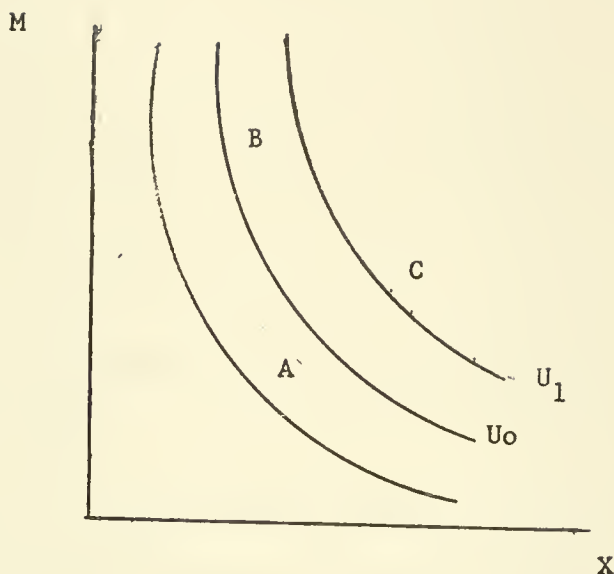
Figure 1

Even though the indifference curves in Figure 1 are drawn with
negative slopes nothing that we have covered in the preceeding analysis
justifies drawing them this way. That they should be negatively sloped
is a very important deduction to be able to make and it is toward this
result that we now wish to proceed.

The slope of the indifference curve represents the rate at which
the consumer is willing to substitute X for M, or M for X, in order to
maintain a given level of utility. Thus, our first task is to see
whether we can deduce what this rate of substitution is. To determine
this rate of substitution we take the total differential of the utility
function. This operation gives us the following equation:

$$dU = f_1 \, dx + f_2 \, dm \qquad (3.1)$$

where f_1 and f_2 are the partial derivatives of U with respect to x and m respectively. But, as noted above, the indifference curve is defined as the locus of all points having the same utility, i.e. U is a constant. Therefore, by taking an arbitrary level of utility, say U_o, and substituting it into the equation (3.1) we get:

$$0 = f_1 \, dx + f_2 \, dm \qquad\qquad (3.2)$$

And by transposing the terms (3.2) can be expressed by:

$$-\frac{dm}{dx} = \frac{f_1}{f_2} \qquad\qquad (3.3)$$

Thus the slope of the indifference curve, or the rate at which the consumer would be willing to substitute a certain amount of X for M, or M for X, is given by $-\frac{dm}{dx}$. The slope of the indifference curve in turn equals the ratio of the partial differentials of U with respect to x and m. So that if we could measure the quantities $f_1 \, dx$ and $f_2 \, dm$ we could directly determine the rate of substitution. However, we are dealing with an ordinal not a cardinal utility function. Consequently these magnitudes cannot be directly measured. But, by examining the rate of substitution of X for M, or M for X, we have shown that if f_1 and f_2 are positive, then the indifference curve has a negative slope--that is, the slope given by the ratio $-\frac{dm}{dx}$ has a negative sign in front of it. Unfortunately, we have not been able to measure what this slope is. To solve this latter problem we must examine the conditions for equilibrium. Or what amounts to the same thing, discover the particular combination of X and M that is sufficient to maximize a specific utility function.

To answer this question we must remember it has been postulated, as part of this theory, that the consumer desires to purchase the specific combination of X and M from which he derives the highest level of utility. The highest level of utility a consumer can obtain is clearly the combination of X and M which, subject to his budget constraint, places him on the highest indifference curve. Thus, in order to specify the point at which the consumer obtains his greatest utility we need to find the combination of X and M that maximizes his utility function subject to his budget constraint.

For any particular time period, the consumer's budget can be represented by

$$y^o = p_x x + p_m m \qquad (3.4)$$

where y^o represents the consumer's total income for this period, and p_x and p_m are the prices of X and M respectively. Because X and M include all possible ways for the consumer to spend his income, the amount spent on X, $(p_x x)$, plus the amount spent on M, $(p_m m)$, must equal his total income y^o.[3]

In order to maximize the utility function subject to the budget constraint we need to identify the combination of commodities that maximizes $U = f(x,m)$, while at the same time satisfying the budget equation

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3/ The reader will remember that we have chosen X to represent a particular commodity, say apples, while M stands for all the other possible commodities on the market, which in turn can be denoted by money.

$y^o = p_x x + p_m m$. Since we have two equations in two unknowns the task is quite straight forward. First, from the budget equation we get everything in terms of the commodity x. Transposing $p_m m$ to the left hand side, dividing through by p_x, and then transposing the left and right hand sides we have

$$x = \frac{y_o - p_m m}{p_x}$$

So that the amount purchased of commodity X, given by x, is equal to the consumer's total income for this period, y_o, minus the total amount he spends on M, $p_m m$, all of which is then divided by the price of X, given by p_x. By a straight forward substitution of this value for x into the utility function, $U = f(x,m)$, we then have the utility function stated in terms of m alone.

$$U = f(\frac{y_o - p_m m}{p_x} , m) \tag{3.5}$$

To find the combination of X and M that maximizes the consumer's utility all we need do now is to find the maximum of (3.5) with respect to m. Having found a maxium value for m, the maxium value of x is immediately found by substituting this value for m back into the budget equation (3.4). For we already know the prices of X and M, i.e., p_x and p_m.

Now sufficient conditions for a maxium are satisfied if $\frac{dU}{dm} = 0$ and $\frac{d^2 U}{dm^2} < 0$. These are what are called the first and second order conditions, respectively. In order to derive the first order conditions we take the first derivative of (3.5) with respect to m, i.e. $\frac{dU}{dm}$, and set it equal to

zero. Taking the first derivative of (3.5) with respect to m we have

$$\frac{dU}{dm} = \frac{d}{dm}\left(\frac{y_o - p_m m}{p_x}\right) + \frac{d}{dm}(m)$$

If we let $\frac{d}{dm} = f_1$ and $\frac{d}{dm}(m) = f_2$ then

$$\frac{dU}{dm} = f_1\left(\frac{y_o - p_m m}{p_x}\right) + f_2$$

But, y_o is a constant, therefore this equation can be reduced to $\frac{dU}{dm} = f_1\left(-\frac{p_m}{p_x}\right) +$

Setting this equation equal to zero we have:

$$0 = f_1\left(-\frac{p_m}{p_x}\right) + f_2$$

By transposing f_2 to the left hand side of the equation and dividing through by f_1 we then have

$$\frac{f_2}{f_1} = \left(\mathrel{\text{\&}}\frac{p_m}{p_x}\right) \tag{3.6}$$

which is the first order condition for a maxium.

By inverting the ratios on both sides of (3.6) we have $\frac{f_1}{f_2} = \frac{p_x}{pm}$.
But, from our earlier analysis (3.3) we also have the equation $\frac{f_1}{f_2} = -\frac{dm}{dx}$. Thus, from the first order conditions for a maxium we can conclude that $\frac{p_x}{p_m} = -\frac{dm}{dx}$ (3.7). That is to say, we have been able to demonstrate that the ratio of the price of X to the price of M is equal to the slope of the indifference curve. Since prices are always taken to be positive, equation (3.7) implies that the slope of the indifference curve, e.g. $\left(-\frac{dm}{dx}\right)$, is always negative. Thus, by employing the first order conditions for a maxiumu we have been able to show that it is correct to draw an indifference curve with a negative slope as was done

in Figure 1. That this is an important conclusion to be able to draw
is illustrated by the following example. Consider a particular consumer
who selects during one interval of time a combination of X and M given
by (x_1, m_1). During the next period of time he selects a different
combination of commodities given by (x_2, m_2). Also suppose that the
utility derived by this consumer from his purchase of (x_1, m_1) is the
same as is derived from (x_2, m_2), so that $U_1 = f(x_1, m_1) = f(x_2, m_2)$.
Also we shall assume that the quantities of X and M selected have not
remained constant during these two periods. Thus from the negative
slope of his indifference curve we can conclude that if he increased his
purchases of X he must have decreased his purchases of M, and vice versa.
Further if his indifference curve was precisely determined, then we could
also specify the decrease in the amount of M purchased needed to offset
a specific increase in X.

If there is to be a single point representing a specific collection
of commodities at which the consumer derives the greatest utility from
his given income, then there must be a unique point at which the
indifference curve and the budget equation coincide. This point is
characterized by the point at which the budget line is tangent to the
indifference curve.. For this to occur the indifference curve must be
convex from below (viewing the curve from the origin), and hence as they
are represented in Figure 1. By an examination of the second order
conditions for a maxium--namely, that $\frac{d^2 U}{dm^2} < 0$ --and the previously

determined slope of the indifference curve (3.3), it can be shown that

this is in fact the case and that the indifference curves can be

represented by the curves as shown in Figure 1.[4] Hence for a given

income and a given set of prices the consumer can be shown to maximize

his utility if and only if he selects the combination of X and M

which is represented by the point of tangency between his indifference

curve and his budget equation.

For example, in Figure 2 the line AB represents the budget equation

$$y_o = p_x x + p_m m$$
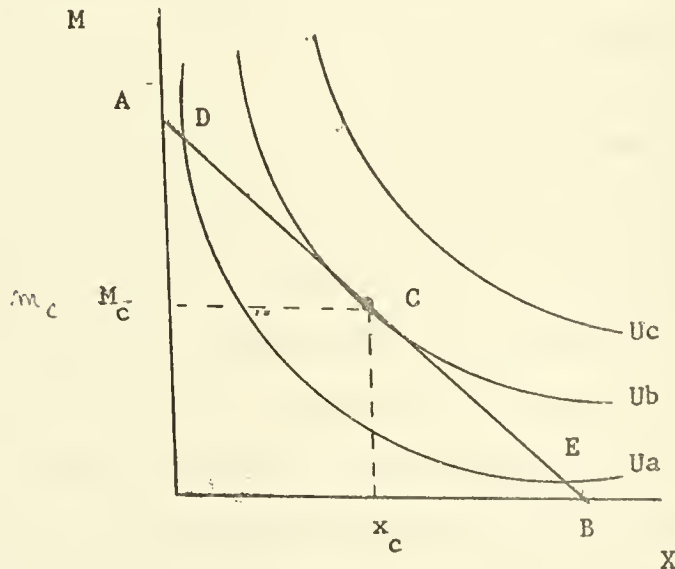
Figure 2

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[4] To be more precise, it can be shown that these indifference curves belong to a family of rectangular hyperbolas whose asymptotes coincide with the coordinate axes.

The intercepts A and B on the M and X axes are the points at which the
consumer's total income is spent on either M or X respectively. The
consumer is postulated to desire as high a level of utility as possible.
And as he cannot spend more than his income the indifference curve he
selects must intersect the line AB in at least one place. If the
consumer decides to purchase the set of commodities represented by
point D on AB, it is quite clear from the diagram that the utility he
derives from this purchase, Ua, is less than the utility he would derive
from purchasing the set of commodities represented by point C. Hence,
since he can afford to purchase the commodities given by point C, the
consumer will select that set of commodities, i.e. (x_c, m_c) and by this
selection he will obtain the greatest utility from his purchases.

One further property of utility functions that can be infered
from the first and second order conditions is that this function is
unique up to a monotonic transformation. This statement means that if,
by a particular set of manipulations, we transform the utility function
U into a new function G(U), and if we also take two specific utility
functions Ua and and Ub where Ua represents a higher level of utility than
Ub, then G(U) is a monotonic transformation of U if when the same manipu-
lations are applied to Ua and Ub, G(Ua) always remains greater than G(Ub).
Another way of getting at the same point is to let Ua represent an index
of utility. Then, as long as the consumer continues to maximize his
utility subject to his budget constraint for a certain utility index, he
will behave in an identical fashion no matter what utility index is chosen,

so long as the new index is a monotonic transformation of the original one.

B . Demand Curves

The consumer's demand curve for a commodity is usually stated in terms of the quantity he will buy once the price is given. These curves are single-valued functions in prices and income. And in the simple case we have been considering they can be represented by: $x = \dfrac{y^o}{2p_x}$ and $m = \dfrac{y^o}{2p_m}$. These particular equations are derived directly from the equations representing the first order conditions of utility maximization. This derivation, however, imposes a constraint upon the interpretation of these demand curves. These curves can be derived only if the second order conditions for a maximum of utility are assumed to be true. That is to say, these curves can be infered only if at the beginning of each new period the consumer continues to maximize his utility. As long as the consumer continues to maximize his utility we can see that once his income and the prices of X and M are known we can immediately infer the quantity of X and M he will purchase.

. Two properties of these demand curves are worth noting: the first, as mentioned above, is that they are single-valued functions of prices and income. This property follows from the properties of the indifference curves we discussed earlier. The indifference curves are negatively sloped and are convex from below. Therefore, it follows that the point at which a consumer maximizes his utility corresponds to a single

combination of commodities. This combination of commodities in turn corresponds to a particular set of prices and income. Thus, it can be directly inferred that as long as the consumer is maximizing his utility, his demand curves can be represented by a single valued function of prices and income.

The second property is that these demand functions can be shown to be homogeneous of zeroth degree in both prices and income. This means that if all prices and income change in the same direction and in the same proportion, then the quantity demanded will remain the same. In terms of the more general demand function for X: $X = \emptyset(p_x, p_m, y^o)$, this property implies that the consumer will not behave as though he were richer (or poorer) in terms of his real income if for the time period under discussion his actual income and the prices of X and M rise (or fall) in the same proportion.

With the consumer's demand function for a commodity stated in terms of his income and the prices of all commodities it now becomes pertinent to inquire into the effects on the demand for one commodity when prices and/or income change. Since we have already observed that the demand function is homogeneous of degree zero we shall now be concerned with changes in prices and income that do not leave the quantity demanded unchanged. In order to examine, independently of each other, the effects of price and income changes the system of equations that represent the

first order conditions for the maximization of utility[5] are further differentiated. This system of equations is then solved for the unknown rates of change. After suitable manipulations a final equation can be deduced which is known as the Slutsky Equation.[6]

$$\frac{\partial x}{\partial p_x} = (\frac{\partial x}{\partial p_x})U = \text{constant} - x(\frac{\partial x}{\partial y})\text{price} = \text{constant}$$

In this equation the term on the left hand side, $\frac{\partial x}{\partial p_x}$, represents the rate of change of the consumer's purchases of X with respect to the changes in the price of X, p_x, while everything else is held constant. As can be seen from the Slutsky Equation, this rate of change, $\frac{\partial x}{\partial p_x}$, is represented as being composed of two parts. The first, or $(\frac{\partial x}{\partial p_x})U$ = constant, stands for the change in the amount of commodity X purchased that is due to what is called the <u>Substitution</u> Effect. While the second part, or $- x(\frac{\partial x}{\partial y})$price = constant, represents the part of the change in the consumption of X that is due to what is called the <u>Income</u> Effect.

In order to explicate the meaning of these terms let us take the case where the price of X is observed to fall. In this case the consumer may wish to buy more of X--that is, substitute extra quantities of X for M--because (i) X has become cheaper, and/or (ii) the fall in the price of X

<u>5/</u> It will be remembered that the first order conditions for a maximum are given by
$$\frac{dU}{dm} = 0 \text{ or } \frac{dU}{dx} = 0.$$

<u>6/</u> For the derivation of this equation see: E. E. Slutsky, "On the Theory of the Budget of the Consumer," American Economic Review, <u>Readings in Price Theory</u>, Irwin, Homewood, Illinois, 1952, pp. 27-56.

has in effect increased the income of the consumer. The <u>Substitution</u>

<u>Effect</u>, $(\frac{\partial x}{\partial p_x})U$ = constant, represents the change that takes place in the

consumer's purchase of X if the price change is simultaneously compensated

for by a change in the consumer's income so that in effect the consumer

is forced to remain on the same indifference curve as he was prior to

the change in the price of X. But, since the consumer's <u>actual</u> income

has been left unchanged the Income Effect represents the difference

between the point (the combination of X and M) given by the <u>Substitution</u>

<u>Effect</u> and the new equilibrium point--namely, the point denoting the

combination of X and M that maximizes his utility for new price of X.

To further clarify these concepts consider the following example.

Take a consumer who is currently maximizing his utility subject to his

budget constraint AB. Then his purchases can be represented by F, on the

indifference curve Ua. (See Fig. 3)

Note
F should be
at point of
tangency of
Ua & AB
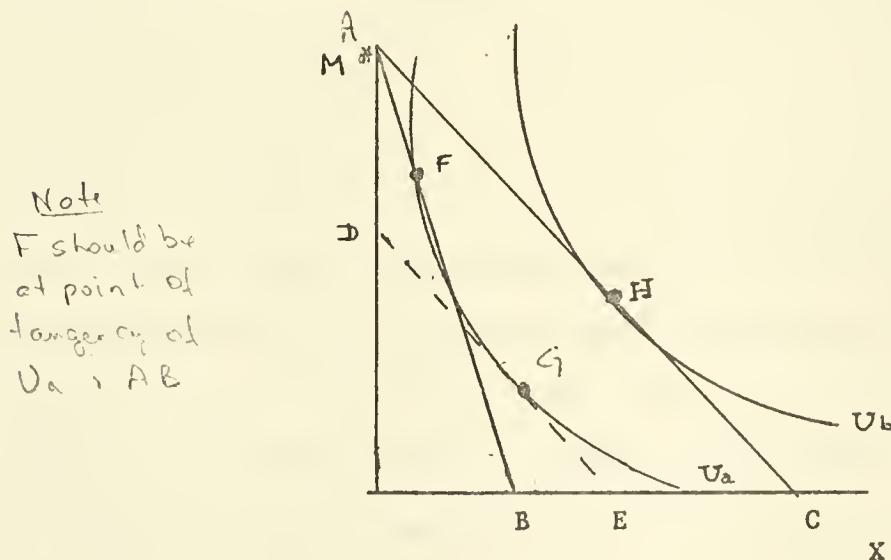
Figure 3

If the price of X falls the quantity of X and M that can now be purchased is clearly greater than before. Hence the new point of equilibrium must be on an indifference curve, say U_b, that is at a higher level of utility than U_a. We shall represent this new equilibrium point by H, lying on U_b at the point where the new budget line AC is tangent to U_b. So far, then, we have used the fall in price of X to show that the consumer can now purchase more of X and M, and that his increased purchases place him on a higher level of utility Ub. The Slutsky Equation refers to the movement from Ua to Ub. As we have seen this movement from F to H can be broken down into two parts. In Figure 3 they are depicted by the changes from F to G, and from G to H. The point G is chosen because it lies on the original indifference curve Ua and because it is also the point of tangency between the curve Ua and a line DE which is drawn parallel to the new budget line AC. Since DE has the same slope as AC the ratio of the price of X to the price of M will be the same in both cases. Thus, G denotes the combination of X and M the consumer would buy if after the price of X fell his income was sufficiently reduced so that he could only obtain the same level of utility, Ua, as before. The movement from F to G corresponds to the Substitution Effect. In a similar manner, the movement from G to H represents the effect the fall in the price of X has on the income of the consumer, if everything else, i.e. the price of M, remains constant. And this effect is called the Income Effect.

Having identified the effects of a price change in a consumer's
purchases we shall now examine some of the further deductions that can
be made about these two components. The first important inference is
that the sign, or direction, of the substitution effect can be shown to
always be negative. This means that if the consumer's income is continu-
ously adjusted so that he remains on the same indifference curve, then if
the price of X rises it can be concluded that the quantity of X purchased
will decrease. Similarly if the price of X falls the quantity purchased
will increase. Unfortunately, the same inference cannot be made for
the Income Effect. And $- x(\frac{\partial x}{\partial y})$ price = constant, may be of either sign.
However, if the income effect is positive and its absolute value is
sufficiently large to make the entire equation positive, then the
commodity X is said to be an inferior good. Essentially this means that
as the consumer's real income rises he wishes to spend less and less of
it on commodity X. Potatoes and bread are the customary examples of
inferior goods. Consider for example a consumer who is sufficiently
poor so that a considerable portion of his income is spent on staples
like potatoes and bread. If the price of potatoes falls, or for some
other reason the consumer's real income rises, then potatoes will be
classified as an inferior good if the consumer with his extra income now
decides to purchase less potatoes and more of some other more appetizing
commodities.

This analysis of the effects of changes in price on the demand for one commodity can be carried a step further to account for the changes in demand for commodity A resulting from the change in the price of some other commodity B. Although somewhat less information can be deduced from the changes in demand for a commodity when there are several changes in other prices--that is, the sign of the substitution effect is now unknown--there is one notable property that can be inferred. Consider the case of n commodities and n prices. Here we shall denote by the substitution effect the change that takes place in the quantity demanded of the ith commodity as a result of a change in the price of the jth commodity. It can then be shown that the substitution effect on the ith commodity which results from a change in the jth price is the same as the substitution effect on the jth commodity that results from a change in the ith price, other things being constant. In other words, one is entitled to conclude that if a consumer's demand for Bourbon whiskey increases at the rate of "three fingers" of Bourbon per $0.50 increase in the price of a quart of Scotch, then his purchases of Scotch will also increase at the rate of "three fingers" per $0.50 increase in the price of a quart of Bourbon, all other things remaining the same.

While little further can be said about the effects on demand of changes in prices of several goods two further conditions concerning the substitution effect still need to be mentioned. If the quantity demanded of ith commodity increases as the price of the jth is increased, then these

commodities are known as <u>substitutes</u>. This condition is expressed in terms of the substitution effect notation by $(\frac{\partial x_i}{\partial P_j})U = \text{const.} > 0$. If on the other hand, $(\frac{\partial x_i}{\partial P_j})U = \text{const.} < 0$—that is, the quantity demanded of the $\underline{i}$th commodity falls as the price of the $\underline{j}$th commodity rises, then these commodities are called <u>complements</u>. Both of these effects are called <u>cross</u>-<u>substitution</u> effects.

2. Theory of Revealed Preference

In the previous section one of the principal postulates was that the consumer possessed a utility function $U = f(x, m)$. From this postulate we were able to proceed to an examination of his indifference curves and eventually to an examination of the properties of his demand functions. A more recent approach to utility analysis, however, starts at a more fundamental level. It takes as its objective the proof of the existence and properties of the indifference map—i.e. the utility function. The goal of this approach is to show that if the observed behavior of a consumer conforms to certain postulates then both the nature and the existence of his indifference map, and hence his demand functions, can be inferred from his actions.[7]

Before we proceed to give a brief account of this approach we need to introduce some further notation. In our earlier discussion we reduced

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[7] The theory of revealed preference was first introduced by P. A. Samuelson and is presented in some detail in <u>Foundations of Economic Analysis</u>, Harvard University Press, 1947, Chapter V.

all the possible commodities that a consumer could choose from to two:
X which stood for one particular commodity and M which stood for a
composite commodity representing the sum total of all other commodities
available to the consumer. Although the analysis could have been
carried out in terms of a set of commodities x_1, x_2, ...,x_n and their
respective prices p_1, p_2, ..., p_n, the two commodities X and M were
introduced for simplicity's sake. While we shall continue to discuss
the theory of revealed preference in terms of X and M, it must be
remembered that M stands for a long list of commodities and their
respective prices. Since we wish to distinguish between the quantities
of X and M purchased at different prices let p_x^o and p_m^o stand for a
particular set of prices of X and M, and p_x' and p_m' for another set of
prices. Then for the prices p_x^o and p_m^o the total expenditure of the consumer
is $y^o = p_x^o x^o + p_m^o m^o$, where x^o and m^o represent the quantities of X and M
purchases by the consumer at these prices. Now consider an alternative
collection of commodities x^1 and m^1 that could have been purchased by
the consumer at the same prices p_x^o and p_m^o. If the consumer had purchased
this second set of commodities his total expenditure would be given by
$y^1 = p_x^o x^1 + p_m^o m^1$. Given this notation we can now go on to consider
the basic postulates governing the consumer's behavior.

The first is that when the consumer makes his selections from the
alternatives that are available to him at the time he will prefer more than
less of a given commodity, if by purchasing more of this commodity his
other selections are not affected. In other words it is postulated that
the consumer will always prefer to purchase a larger to a lesser amount
of M if this larger purchase of M does not affect in any way the amount

of X that is available to him.

The next two postulates are concerned with interpreting the actual choices that the consumer is observed to make from the various alternative batches of commodities available to him. For example, consider two possible commodity batches $p_x^o x^o + p_m^o m^o$ and $p_x^o x^1 + p_m^o m^1$. We observe that when presented with a choice between these alternatives the consumer selects $p_x^o x^o + p_m^o m^o$. Then by the first postualte we can infer that $p_x^o x^o + p_m^o m^o \geqq p_x^o x^1 + p_m^o m^1$, or alternatively that $y^o \geqq y^1$. That is to say, since the consumer selected y^o in preference to y^1, and since by the first postulate y^o costs at least as much as y^1, y^o is said to be "revealed" to be preferred to y^1.

The second postulate states that if y^o is revealed to be preferred to y^1, y^1 may never be revealed to be preferred to y^o. This is what is called the Two-Term Consistency Condition.[8] This postulate states that if during one period of time the consumer reveals by his purchases that y^o is preferred to y^1, then it would be inconsistent, and hence a violation of the first postulate, if in the same situation he decided to purchase y^1 instead of y^o. If this situation arose y^1 would be revealed preferred to y^o. Hence we could conclude that $y^1 \geq y^o$. But by his earlier selections the consumer had revealed that $y^o \geqq y^1$. Thefefore, the consumer would be declared to be inconsistent in his purchases and his

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8/ The name for this requirement is taken from J. R. Hicks, A Revision of Demand Theory, Oxford, 1956, p. 21.

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behavior would not be considered to fall within the limits of this theory.

The third postulate not only requires the consumer to be consistent
in his purchases but also that his revealed preferences must be transitive.
For example, if y^o is revealed to be preferred to y^t, and y^i is revealed
to be preferred to y^2, which in turn is revealed to be preferred to y^3,...,
which in turn is revealed to be preferred to y^n, y^n must never be
revealed to be preferred to y^o. Amongst the revealed preferrences there
must be no circularity, and the consumer must select his bundles of
commodities so that his revealed preferences are transitive.

From these three postulates it can be shown that the consumer must
possess an indifference map--that is, a set of indifference curves each
of which represents a different level of utility as in our earlier
examples. Further, for any particular consumer these postualtes allow us
to construct his indifference map by presenting him with various sets of
suitable chosen commodities and prices and simply observing his responses.
It must be remembered, however, that the consumer's behavior must conform
with the postulates before such experiments can be carried out.

Once the indifference curves have been ascertained we can then proceed
by this method of analysis to derive all the properties of the indifference
and demand curves that were derived from the utility approach. For example,
in the case where the consumer is forced to move along one indifference
curve it can be shown that the substitution effect is always negative.

Also the demand curves can be shown to be homogeneous and of degree zero. Substitutes and complements are defined in a similar manner and the equality of the cross-substitution effects can also be shown to hold true.

The chief characteristic of the Revealed Preference Theory is that continuous and differentiable functions are avoided and are replaced by expressions dealing only in finite differences. The motivation for this alteration was provided by the observation that "in the world of real phenomena all changes are necessarily finite, and instantaneous rates of change remain only limiting abstractions."[9] By reformulating the Theory of Consumer Demand in terms of expressions containing only finite differences it was felt that the theory would now be stated in terms of observable quantities and hence would be more open to verification by empirical test.

9/ P. A. Samuelson, op. cit. p. 46.

CHAPTER IV

THE FUNCTION OF CONCEPTS IN THE THEORY OF DEMAND

So far we have discussed the role of deductive schema in the analysis

of scientific theories, and we have described the body of economic theory

that purports to explain the behavior of consumers in the market place.

Accordingly, we can now investigate the theory of demand to see whether

it does in fact perform the functions that are required of it if it is

to be considered a part of science.

One of the objectives of empirical science is to establish general

principles by means of which the particular phenomena under consideration

can be explained and predicted. These general principles are contained

in the hypotheses and generalizations of which a theory is composed. In

the statement of a theory terms and concepts are used which may or may

not be directly related to observational phenomena. However, if the

theory is concerned with empirical phenomena, and if the theory is to

meet the criterion of falsifiability, then both the theory and its concepts

must refer to a particular set of empirical phenomena. While the next chapter

will be concerned with examining the empirical hypotheses of the theory

of demand, we shall concern ourselves in this chapter with an analysis of

the empirical content of its concepts and terms.

Before we can proceed with the analysis we first need an analytic

framework with which to carry out this investigation. The first part

of this chapter will be devoted to presenting such a framework.

1. The Formation of Concepts in Science[1]

At the beginning of a scientific inquiry into a new subject area the descriptions of the phenomena encoutered, as well as the observed regularities and generalizations are frequently stated in terms of the vocabulary of everyday language. As the new discipline grows, terms and concepts are introduced so that before long a system of specialized and abstract concepts is in use along with a corresponding technical vocabulary. One of the most frequent ways in which these concepts are introduced is by defining them in terms of other concepts. The term "definition," however, can be used in several different senses. And in order to explore the methods by which concepts are introduced into a theory we must first examine the different ways in which a term can be defined.

A Nominal Definitions

A term or concept is introduced by what is called a nominal definition when the new term or expression, say A_1, is stated to be synonymous with another term or expression, say A_2, whose meaning is already understood. Thus, a definition is called nominal, if it can be put into the following form:

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[1] This section is particularly indebted to Carl G. Hempel's paper, "The Fundamentals of Concept Formation in Empirical Science," International Encyclopedia of Unified Science, University of Chicago Press, 1952, Vol. II, No. 7.

Let the term or expression A_1 be synonymous with the term or
expression A_2.

From this form we can see that a nominal definition is concerned
with linguistic expressions and therefore must contain the names for
these expressions. The usual way of forming a name for an expression is
to put the name between single quotation marks. For example, we could
characterize the definition of a 'monopolist' or an 'utility index' in the
following way:

Let the term 'monopolist' be synonymous with the expression 'a market
with a single seller'.

Let the term 'utility index' by synonymous with the expression 'the
numbers assigned by a utility function to alternative combinations of
commodities'.

The technique of identifying these expressions by means of quotation
marks is not the only one that can be used. Various notations exist for
denoting this relation but we shall not bother to discuss them here. The
point that we wish to make is that a nominal definition can be characterized
as a stipulation to the effect that the term or the expression specified
by the first term, or definiendum, is to be considered synonymous with
the term or expression specified by the second term, or definiens.

This method of defining a term does not have to be restricted to
the case when we are introducing a new term. A nominal definition can
be used to identify a term that is part of another expression, such as a
property of being a monopolist. Or this method of definition may be used

to denote by a particular name a certain class of objects, a specific

relation between objects, or a function that relates the properties of

particular objects in a specified manner. Consider for example the

definitions of the following terms taken from the theory of the firm:

An 'Isoquant' is defined to be synonymous with the expression 'the

locus of all combinations of a firm's inputs that yield a specified

output level'.

A 'production function' is defined to be synonymous with the

expression 'the function that states the quantity of a firm's output

in terms of the quantities of the variable inputs'.

The term 'marginal cost' is defined to be synonymous with the

expression 'the first derivative of the total cost curve taken with

respect to output'.

From these examples we can see that a nominal definition allows us

to single out an expression, class, relation, or function and to replace

it with a term that is frequently called a 'concept'.

It must be remembered, however, that this concept is a name and is

only given a linguistic meaning by the process of stipulating that the

concept shall be synonymous with another expression whose meaning is

already understood.

B   Real Definitions

A "real" definition, on the other hand, is not a stipulation

determining the meaning of some expression. Rather it is a definition whereby

the definiens consists of a set statements that are the necessary and

sufficient conditions for the meaning of the definiendum to hold "true."[2]/
For example, in the theory of the firm a perfectly competitive market is
asserted to exist when the following conditions are satisfied: (1) all
firms produce a homogeneous product and there are no advantages or
disadvantages accruing to any of these producers by selling to one
customer rather than another, (2) both firms and consumers are sufficiently
numerous so that the sales or purchases of each unit are small with respect
to the total volume of transactions, (3) both firms and consumers have
perfect knowledge of current prices and bids, and both take advantage of
every opportunity to increase their respective profits or utility, and
(4) there are neither costs nor restrictions on entry and exit from the
market. If we label these conditions A_x, B_x, C_x, and D_x respectively, then
the real definition of a competitive market, M_x, would be given by the
following sentence.

X is a competitive market if and only if x satisfies the conditions
A, B, C, and D. Or equivalently: $M_x \equiv A_x \cdot B_x \cdot C_x \cdot D_x$.

As can be seen from the above, the use of the equivalence sign (the
'if and only if' part) does not represent a convention concerning the use
of the term M_x.* Instead it is an assertion about the competitive market,
M_x, which claims to be true. Since this definition constitutes as assertion
that certain conditions are both necessary and sufficient for the existence
of a competitive market, our next concern is to examine the ways in which
such an assertion can be shown to be "true"--that is, we now wish to

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2/ The meaning of this term will be discussed presently.

investigate what is meant by the word "true".

One approach to this question would be to suggest that the expression $A_x \cdot B_x \cdot C_x \cdot D_x$ is synonymous with the expression 'x is a competitive market'. In this case we have what is called an <u>analytic definition</u> of the term. In an analytic definition the meaning of the concept is given by an analysis of the meaning of the parts on the right hand side of the equivalence sign. Thus, the "truth" of the proposition $M_x \equiv A_x \cdot B_x \cdot C_x \cdot D_x$ is discovered solely by an examination of the meaning of its constitutent parts. And no reference is made to empirical phenomena.[3/] The validation of an analytic definition is carried out by a process that is called <u>meaning analysis</u>. For example, an English dictionary provides a long list of analytic definitions there being at least one for each word in the language. These definitions are shown to be true in the dictionary by demonstrating that, within whatever degree of approximation is allowed by the language, the meaning of the term on the left hand side of the equivalence sign is synonymous with the meaning of the terms that appear on the right hand side. And in cases where there are a number of ambiguities several sentences are usually included to point out these differences in meaning.

Having considered the problem of validating the proposition $M_x \equiv A_x \cdot B_x \cdot C_x \cdot D_x$ when it is interpreted as an analytic definition

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<u>3/</u> For an analogous method of determining the truth value of a statement the reader is referred back to the discussion on the interpretation of pure deductive systems given in Chapter II.

we can now turn our attention to an alternative interpretation. Consider, for example, the case where M_x is no longer considered just to have the same meaning as $A_x \cdot B_x \cdot C_x \cdot D_x$. Instead, it is now asserted that, as a matter of empirical fact, the four conditions A, B, C, and D, are simultaneously satisfied by those and only those phenomena which are also competitive markets. Under this interpretation the sentence $M_x \equiv A_x \cdot B_x \cdot C_x \cdot D_x$ has the characteristics of an empirical law. It can be refuted or confirmed by a direct empirical inquiry into the characteristics of competitive markets. In this case the real definition constitutes what is called an empirical analysis of the properties of a competitive market. Consequently, in order to test whether the definition of M_x is 'true' or 'false' we would have to conduct an empirical investigation. This investigation would be concerned with determining whether the evidence supported the following two conditions: (i) that each of the four conditions represented by A, B, C, and D can be shown to exist in market situations, and (ii) that the conditions A, B, C, D hold simultaneously in only those situations that are called competitive markets. If the empirical evidence disagrees with either of these conditions, then one can conclude that the definition is 'false' and that $M_x \equiv A_x \cdot B_x \cdot C_x \cdot D_x$ does not constitute a true definition of a competitive market.

From this discussion it should be apparent that empirical analysis, meaning analysis, and nominal definition all differ from each other. As we have just seen, empirical analysis is concerned with empirical phenomena.

It states the characteristics which are, as a matter of empirical fact, both necessary and sufficient for the occurrence of the phenomena under discussion. Meaning analysis, on the other hand, deals with linguistic expressions and their meanings. Thus, an analytic definition is considered to be 'true' or 'false' depending on whether the expression on the left hand side of the equivalence sign is, or is not, synonymous with the expression on the right hand side. A nominal definition, however, is employed to introduce a new concept or term by stipulating that the new term is to be considered equivalent to some other term already a part of the vocabulary. The difference between meaning analysis and a nominal definition can be more readily perceived if one remembers that in the former the expressions on both sides of the equivalence sign must previously be understood, while in the latter it is only the definiens that must already be incorporated in the working vocabulary.

C Function of Concepts in Empirical Science

In order to predict and to explain the occurrence of specific events, general relations must be established between the occurrences of different phenomena so that the occurrence of an individual event can be deduced from these general principles. Thus, one of the fundamental requirements of a science is a set of general principles and laws that permit the explanation and prediction of particular events. Clearly, to construct such laws concepts are needed that are suited to the process of constructing generalizations. In a given body of theory, then, many of the concepts

will be highly abstract and will bear little direct relation to observational phenomena. If the theory is to be considered a part of empirical science certain connections must exist that link these abstract concepts to the vocabulary of observational phenomena. Unless these connections exist, the concepts and terms of the theory cannot have any empirical content. And consequently the theory as a whole cannot be considered to be a part of empirical science.

Consider, for example, a theoretical system whose terms and concepts are such that they permit the establishment of a set of general principles and laws, all of which are deducible from a set of, what we will call, basic postulates. If we represent this theory in terms of a deductive system we can immediately decide if a given conclusion or hypothesis is logically true or not--that is, if it can be legitimately inferred from the basic postulates.[4/] But, to be able to test whether or not the derived conclusions are empirically true, an adequate empirical interpretation must be given to the terms and concepts embedded in the theory. Certainly not all concepts in a theory need to have direct empirical interpretations. These concepts are usually called "theoretical concepts".[5/]

4/   In an analogous manner a real definition of a term is tested for its 'truth' or falsity by meaning analysis.

5/   The term "theoretical concept' is taken from R. B. Braithwaite, op. cit. p. 51, and is used to identify terms like, Schreodinger's ψ function, "electric-field vector", "electron", etc., that are employed in general laws but are not themselves observational terms.

But even though theoretical concepts have no observational counterparts, if the theoretical system of which they are a part is given an adequate empirical interpretation, then this interpretation in turn confers empirical meaning on these constructs.

An empirical interpretation of a theory essentially plays a double role. It indirectly confers empirical content on the theoretical concepts while at the same time permitting the theory's hypotheses to be capable of refutation by empirical test. Thus, a theoretical system that lacks an adequate empirical interpretation is incapable of being tested and cannot constitute a theory of empirical phenomena.

2. Concepts and Definitions in the Theory of Demand

Having developed our analytic framework it is now time to proceed with the analysis. The remainder of this chapter will be devoted to an examination of both the methods used to formulate and the empirical interpretation given to the concepts and terms that are employed in the Theory of Demend. Despite the fact that this analysis will be carried out on individual concepts and terms, care will be taken not to overlook the fact that one cannot fully evaluate a concept standing by itself. That is to say, we recognize that a concept can have explanatory and predictive power only within the context of an interpreted theory.

A The Concept of Utility

We shall start our analysis with an examination of utility theory and the concept of a utility function. In Chapter III we saw that a utility

function is defined in terms of a consumer's purchases during a specified
period of time. Also we saw that if we allow X to stand for one commodity,
and M to stand for a composite commodity that represents the remaining
alternatives, then the utility function could be expressed as $U = f(x, m)$,
where x and m represent the quantities of X and M that are selected.[6]
Since utility functions have ordinal properties, if we have two different
collections of X and M--namely, (x_1, m_1) and (x_2, m_2)--then it is possible
that the combination of x_1 and m_1 has a higher utility to the consumer,
other things being equal, than x_2 and m_2--i.e. $U_1 > U_2$. However, before
we are able to determine the truth value of such a statement we must first
be sure we are clear how the concept of a "utility function" is introduced
into the theory.

One possibility is that the concept of a utility function is to be
considered as a real definition capable of validation by empirical
analysis. In this case the statement that the ith consumer has a
utility function, e.g. $U_i = f_i(x,m)$, asserts that as a matter of empirical
fact consumer i has a utility function if and only if he buys a quantity
of X and M, at their prevailing prices, such that $y_i = p_x x + p_m m$, where y_i
represents the ith consumer's total income for the period under discussion.
Since M represents all the possible commodities available to consumer i

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6/ It should be clear to the reader that the Hicksian utility function
    that we are employing can, without any alteration in the analysis, be
    replaced by the more general form $U_i = U_i(q_{i1}, q_{i2}, \ldots, q_{in})$, where U_i
    represents the utility function of the ith consumer and $q_1, q_2, \ldots, q_n$
    the n commodities that he selects.

other than commodity X, the combination of $p_x x + p_m m$ <u>must</u> <u>always</u> represent
whatever purchases consumer <u>i</u> makes during the specified period of time.
For example, if consumer <u>i</u> spends 10 per cent of his income on X and all
the rest on M, then this combination will satisfy the definition equally
as well as a combination composed of 90 per cent of y_i spent on X and only
10 per cent spent on M. It follows, therefore, that there is no combina-
tion of X and M that will <u>not</u> satisfy the definition.[7] But we have
already seen that if the truth value of a statement is independent of the
truth values of its component parts, then it is not pertinent to submit
the statement to empirical test.[8] Thus, one can conclude that the concept
of a utility function cannot be considered as a real definition capable
of empirical validation.

A second possibility is to consider the concept of a utility function
to be introduced into the theory by an analytic definition. If this is
the case the truth or falsity of the definition can only be determined
by examining the meaning of the terms contained in the two expressions.
On the other hand this concept could also be interpreted as being introduced
by a nominal definition where the meaning of the term 'utility function'
was stipulated to be synonymous with the functional relation $f(x,m)$. In
either event it is clear that, taken by itself, the truth value of the
concept of a utility function cannot be determined by empirical analysis.

That this should be so is readily apparent once we consider the notion
of an indifference curve. Referring again to Chapter III we see that an

[7] It must be remembered that any savings or unspent monies are also
considered to be contained in M.

[8] The reader is referred to the discussion on interpreting deductive
systems in Chapter II.

indifference curve is defined as the locus of points described by those combinations of X and M that yield for a consumer the same level of utility. Hence, the concept of an indifference curve clearly places some restrictions on the concept of a utility function. If we allow U' to represent the indifference curve that has utility U' at all points on it we can represent it by the following expression $U' = f'(x,m)$. Now, if the concept of an indifference curve is taken to be capable of verification by empirical analysis, we can see that this would imply the following:

U'_i is an indifference curve for consumer $\underline{i}$ if and only if $U_i = U'_i$ for the combinations of X and M that satisfy $U_i = f_i(x,m)$.

This statement affirms that it is possible for consumer $\underline{i}$ to select a combination of X and M such that $U_i \neq U'_i$. But before we can engage in an empirical analysis to find out whether this is in fact the case, we need to have some information or general principles about the behavior of consumer $\underline{i}$. This information is provided for us by the three basic postulates of utility theory which are as follows:

P_1: For all possible pairs of alternatives A and B the consumer can state whether he prefers A to B, or B to A, or whether he is indifferent between them.[9]

P_2: For any pair of alternative A and B only one of these three possibilities may hold true at any one period of time.

P_3: If for three possible alternatives A, B, and C, the consumer

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[9] It should be noted that alternatives A and B each entail some combinations of X and M at their respective prices.

prefers A to B, and B to C, then he will prefer A to C.

From these postualtes we can now infer that it is quite possible for consumer $\underline{i}$ to select a combination of X and M such that $U_i \neq U'_i$. Also it is evident that if consumer $\underline{i}$ behaves in a fashion that is consistent with these postulates, then we can also infer that there are several combinations of X and M that will satisfy the definition of an indifference curve--that is, $U'_i = f'_i(x,m)$, where $U_i = U'_i$. Since empirical meaning has now been given to the concept of an indifference curve, the concept of a utility function is no longer devoid of empirical content. But it must not be forgotten that this empirical content is introduced by three postulates, P_1, P_2, and P_3. Thus, these postulates must be subject to empirical analysis if the theory of utility is to be confirmed or disconfirmed by empirical investigations. If these postulates can be empirically veri-fied, a question we shall examine later on, then we are now at liberty to explore the remaining important concepts in the theory of utility.

B Utility Maximization

Whether one prefers the approach of the neo-classical theory of utility or that of the theory of revealed preference, the next important concept that we shall examine is the concept of a maximum of utility. Now a utility function is defined in terms of combinations of commodities. Therefore, the point at which a consumer reaches a maximum of utility must be defined in terms of a particular set of commodities.

From the analysis presented in Chapter III we know that both the first order and second order conditions must be satisfied if this maximum is to exist. The first order condition ensures that we have reached a point where there is either a maximum, minimum, or a saddle point. And the second order condition tells us which one of these possibilities is in fact the case. From these conditions it is possible, both in the theory of utility and the theory of revealed preference, to infer that the indifference curves can be represented by a family of rectangular hyperbolas. Also that the ith consumer's utility is at a maximum at the point at which his budget equation is tangent to one of his indifference curves. (See pp. 46-51). This maximum can also be demonstrated to be unique. Hence, it will be sufficient for our purposes to restrict our attention to the first order conditions.

Since there is only one point at which a maximum can occur, this point, or combination of commodities, can be represented by the following:

U^* is a point of maximum utility if and only if the quantities selected of X and M are such that $\frac{dU}{dm} = 0$--that is, the point at which the budget equation $y = p_x x + p_m m$ is tangent to the indifference curve $U^* = f^*(x,m)$.

For this concept to be substantiated by empirical analysis we must be able to test whether a particular selection of commodities provides a maximum of utility for consumer i or not. Our earlier analysis showed that the first order condition was met when the ratio of the prices of X and M

was equal to the ratio of the marginal utility of X to the marginal
utility of M for consumer i [10/] . Since the utility function only has
ordinal properties the concept of marginal utility, denoted in equation
(3.6) by f_1 or f_2, has no empirical interpretation. But, we pointed
out that the ratio of the price of X to the price of M was also equal
to the slope of the indifference curve. [11/] Therefore, it follows that
the empirical criterion of whether a specified set of commodities yields
a maximum of utility for consumer i can now be stated in terms of the
ratio of the prices of X and M and the slope of his indifference curve.
If both of these ratios are empirically determinable, then it will be
possible to test whether a given set of commodities does in fact yield a
maximum of utility for consumer i.

Unfortuantely, it is not immediately clear whether these ratios are
in fact empirically determinable. To know the ratio of p_x to p_m for
example, implies that we know the price of commodity X as well as the
price of the composite commodity M. Now the price of X is easily
obtained from direct observation. But what about the price of M? After
all, M represents all the remaining commodities available to consumer i
during the specified interval of time, and m that subset of M that was
selected at price p_m. Hence, the exact empirical meaning of this price
ratio is not at all clear. Consider also what is meant by the slope of
the indifference curve. Analytically, it means the rate at which consumer
i would be willing to substitute X for M and M for X. But how is this

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10/ See equation (3.6), p. 44.

11/ See equation (3.3), p. 41.

slope to be interpreted empirically?

The normal procedure in economic analysis for handling both of these problems is to take the case of a restricted number of actual commodities, preferably two, and treat all the remaining commodities and prices as fixed. The selected commodities are then examined, one at a time, to determine the price ratios and a linear approximation to the slope of the indifference surface. Such a procedure, however, does not provide us with a very satisfactory empirical interpretation. At best it relies on the economist's ability to identify each of the relevant commodities as substitutes or complements of each other (concepts that will be examined below). Further, this comparison of the price ratios and the slope of the indifference curve has empirical meaning if and only if a fourth postulate about the consumer's behavior is empirically true:

P_4: The consumer will purchase that combination of commodities that yields him the highest level of utility.

If this postualte is supported by the relevant empirical tests,[12] then, however, difficult in practice, it would at least in principle be possible to empirically ascertain whether or not the price ratios were equal to the slope of the indifference curve. We can conclude, therefore, that the empirical validity of the concept of a maximum of utility also depends on the ability to confirm the basic postualtes, P_1, P_2, P_3, and P_4 by empirical tests.

12/ We shall examine this question at length later on.

C Substitutes and Complements

As noted above, the empirical interpretation of whether a consumer has maximized his utility or not rests in part upon the identification of the commodities that he selects as substitutes or complements. In the previous chapter, it will be remembered, the concepts 'substitute' and 'complement' were defined in terms of the effects on the demand for the ith commodity when the price of the jth commodity was altered, while the utility derived from the purchase and all other prices were kept constant. These concepts were expressed more formally by the following notation:

Commodity x_i is a substitute if and only if $(\frac{\partial x_i}{\partial p_j})U = \text{const.} > 0$

Commodity x_i is a complement if and only if $(\frac{\partial x_i}{\partial p_j})U = \text{const.} < 0$

From these definitions it is evident that if we wish to be able to establish whether or not a given commodity is a substitute for consumer i, we must first find a situation in which the prices of all commodities except x_j remain unchanged. Once this situation has been discovered we must then observe the effects of the change in the price of x_j, on his purchases of x_i. Further, since the utility derived from this new selection of commodities must remain constant, not only must consumer i be indifferent between these two alternatives, but we also must have some method for determining whether the utility derived from the new purchases has been held constant or not. Consequently, to be able to

ascertain whether commodity x_i is a substitute or not, we need to be able to submit the $\underline{i}$th consumer's utility function to empirical analysis.

But we have already seen that the concept of a utility function derives its empirical content from the concept of an indifference curve. In turn, the indifference curve is given empirical meaning if and only if the behavior of consumer $\underline{i}$ conforms to the postulates P_1, P_2, and P_3. We have also seen that the notion of a maximum of utility depends in part on the economist's ability to identify whether a given set of commodities are substitutes or complements. Therefore, it follows that the source of empirical content for all these concepts lies in the four basic postualtes of behavior. If these postulates can be empirically confirmed, then these concepts can be subjected to empirical analysis. And the implications of this theory can then be tested by confrontation with observed behavior.

D The Demand Curve

The last important concept we shall examine in detail is that of the demand curve itself. As noted in Chapter III, demand curves for particular commodities can be directly derived from the first order conditions of utility maximization. These curves are single valued functions and are stated in terms of prices and income. The dependent variable is the commodity that is currently under consideration. Thus, the demand function for commodity X for the $\underline{i}$th consumer can be expressed as before by:

$$x_i = \frac{y_i}{2p_{x_i}} \tag{4.1}$$

or in more general terms by

$$D_{ij}(x_j) = f_{ij}(p_1\ p_2\ \cdots p_m, y_i) \tag{4.2}$$

where

$$p_1,\ p_2,\ \cdots,\ p_m$$

represent the prices of all the relevant commodities, and D_{ij} represents the ith comsumer's demand function for the jth commodity x_j. As in the previous cases it is easy to show that this definition of a demand curve, if considered in terms of a real definition, is analytically true. That is to say, the meaning of the expression on the left hand sides is in agreement with the meaning, customarily given to the expression on the right hand side. What we are interested in examining, however, is whether the components of this definition have sufficient empirical interpretations so that the definition, by itself, is open to empirical analysis.

Taking the first definition (4.1) we have the ith consumer's demand for X stated in terms of his income and the prevailing price p_x. Manifestly, if this is all there really were to the demand function for X, then there would be no questioning the empirical content of this function. For in this case all we would have to know is the ith consumer's income, the prevailing price of X, and we could predice forthwith the quantity that he would consume. Unfortunately, the situation is not quite so simple as it might seem. The first point to note is that the demand functions themselves, are derived from the theory of utility under the condition that

consumer i is maximizing his utility. And we have already examined the problems involved in trying to determine when consumer i is maximizing his utility. Hence, if the empirical validity of the demand function is to rest solely on the condition that the consumer is at all times maximizing his utility, then we are back to the position where the empirical content of these concepts rests entirely upon the empirical validity of the four basic postulates. Our current concern then is to examine these demand functions to see whether there is a further basis for empirical interpretation so that the empirical content of the entire theory need not be contingent upon the four postulates.

To start with, if we take the case where we are dealing with the two commodities X and M, the ith consumer's demand for X will be a single valued function of the price of X and his income. However, this function is derived by taking partial differentials with respect to X--that is, by holding the price and quantity of M constant. Therefore, this demand function can only represent the ith consumer's demand for X in the case where everything except the price of X is held constant.

In the case of the more generalized demand function we have the ith consumer's demand for commodity x_j expressed as a function of the prices of all other commodities as well as of the consumer's income. However, in this case the form of the function is not spelt out in any detail. For example, if we wished to investigate the effects of changes in the prices of some commodities on the demand for x_j we would have to employ

the analytic framework given to us by the Slutsky Equation. In other words

to be able to examine the effects of price changes on the demand for x_j

we would need to identify and compute the substitution and income effects.

To determine the substitution effect we need to vary the price of x_j while,

by suitable manipulations of his income, the consumer is kept on the same

indifference curve. But before we can subject the concept of a substitu-

tion effect to empirical analysis we need to have some technique for find-

ing out whether the ith consumer has been kept on the same indifference

curve throughout the operation. An examination of the Income Effect is

no less difficult since in this case we are concerned with keeping all

prices constant while income is allowed to vary. The algebraic sum of

these two effects gives us the rate at which the ith consumer changes his

purchases of x_j with respect to the changes in the price of x_j, while all

other prices and income are held constant. Hence, although we started with

a generalized demand function the only way in which the concepts and

components of the function can be analyzed is by treating the world as though

one thing varied while everything else remained constant. In fact we

have not improved on our earlier position. At that point there were only

two commodities and the empirical content of these functions depended upon

the empirical truth value of the postulates.

There is one further property of demand curves that still remains t o

be examined. It is the condition that the slope of the demand curve

for x_j is almost always negative. We have just noted that the rate of change

of the quantity demanded of x_j with respect to the price of x_j can be
broken down into substitution and income effect components. Since
the slope of the demand curve is expressed by this rate of change we can
see that the sum of the substitution and income effects should also be
a negative number. However, demand curves are not <u>always</u> negatively
sloped--that is, the demand for some commodities increases as the
price rises. Perfumes, items of jewelry, and fur capes are examples
of some articles that frequently have positively sloped demand curves.
Therefore, the negative slope cannot, without further qualifications,
be taken as a universal, empirical property of these curves. For example,
it will be remembered from our earlier discussion that the slope of the
demand curve, i.e. $\frac{\partial x_i}{\partial P_j}$, is negative if and only if the absolute value
of the income effect, i.e. $\left| -x_i \left(\frac{\partial x_i}{\partial y}\right) \text{Price} = \text{const.} \right|$ is not sufficiently
large to make $\frac{\partial x_i}{\partial P_j}$ also positive in value. That is to say, it is only
the substitution effect, i.e. $\left(\frac{\partial x_i}{\partial P_j}\right) U = \text{Const.}$ which always has a negative
value. And if the absolute value of the income effect is greater than
the absolute value of the substitution effect, then the demand curve
will have a positive slope. Now the empirical confirmation of the
basic postulates has already been shown to be a prerequisite for the
actual determination of the substitution and income effects. Therefore,
without further qualifications, the property of a negative slope does not
provide any direct, additional empirical interpretation.

Conclusions

From this analysis it has become apparent that the concepts of the

economic theory of consumer behavior are open to empirical analysis
if and only if the four postulates of the theory of utility are
themselves confirmable by empirical investigations. This is not to say
that there are no other ways of introducing empirical content into these
concepts. But rather our investigation has shown that unless these
postulates are empirically confirmed then the remaining sources of
empirical interpretation cannot be employed. This is an important
conclusion. It asserts that these concepts must be classified as
theoretical concepts until it is demonstrated that the postulates of
the theory of utility are supported, and not disconfirmed, by empirical
tests.

Since the theory of demand can only apply to those consumers whose
behavior accords with these basic postualtes we shall now turn our
attention to an examination of the conditions under which these postulates
can be empirically confirmed. And if these postulates are to be considered
a part of a theoretical structure whose function is to explain and
predict consumer behavior, then we must also examine the function of
postulates and laws in the explanation and prediction of particular
events. It is toward both of these tasks that the next two chapters
are devoted.

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CHAPTER V

THE FUNCTION OF LAWS IN THE THEORY OF DEMAND

In the previous chapter we examined in some detail the concepts and terms employed in the theory of consumer behavior as well as their possible sources of empirical interpretation. But, concepts and terms are introduced into a theoretical system in order to formulate general laws and hypotheses. And it is only within the context of such a theoretical system that a concept can have explanatory and predictive power. Accordingly, our intention is to examine the function of these laws, and thus of the concepts as well, in the "explanation" and "prediction" of economic events.[1/] In so doing we shall make a point of investigating the ways in which the postulates about consumer behavior can be subjected to a process of refutation by empirical test.

1. The Function of General Laws in Explanation and Prediction [2/]

A General Laws

In the literature of the physical sciences the term "general law" is usually taken to mean a universal statement of conditional

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[1/] While a large number of books and articles have been written on the subject of "explanation" and "prediction", both in the social as well as in the physical science, with which the author has no desire to compete, there are a sufficient number of differences in these explications to leave in doubt precisely what is meant by these terms. Because the analysis in this essay involves the explicit use of these terms, our presentation will be greatly facilitated if both reader and author can agree, for the purposes of this essay, on one meaning for these terms.

form,[3] stated in such a manner that it can be subjected to confirmation

or disconfirmation by empirical test. A statement is universal if it

asserts that every occurrence of a specific kind of event is always

related in a particular manner to the occurrence of another specified

kind of event.

For example, the well-known law relating the free fall of a body

near the earth's surface to its acceleration is given by $\frac{d^2 s}{dt^2} = 32$. That

this is a universal statement is attested by the fact that the equation

asserts that every body which is near the earth and is freely falling

with fall with an acceleration of 32 feet per second. That this statement

is classified as a general law is attested by the fact that it is stated

in such a manner that it can be subjected to a process of refutation

by empirical test. If the law had been stated as $\frac{d^2 s}{dt^2} = 17.5$, it would

not have been long before counter examples were discovered and the

universal applicability of the law challenged.

2/ This section is indebted to the excellent paper by Carl G. Hempel,
"The Function of General Laws in History," Journal of Philosophy,
Vol. 39, 1942, pp. 35-48. (reprinted in H. Feigl and W. Sellars,
Readings in Philosophical Analysis, New York, 1949.)

3/ The term "conditional" refers to the form in which the statement is
expressed. We have represented the conditional in our logical notation
by '$\rightarrow$' (See ChapterII). Hence, the statement "all P's and Q's" i s of
universal and conditional form if we construe it as stating for all
values (x_i) of x it is the case that $\underline{P}x_i \rightarrow \underline{Q}x_i$.

It should be noted that while a universal statement is not considered to be a general law unless it can be subjected to empirical test, it does not follow that all general laws are in fact well confirmed by empirical evidence. The criteria that allow one to determine whether a law is satisfactorily confirmed are distinct from those that allow one to determine whether it is possible to subject a general statement to an empirical test. We are concerned with the function of laws in a theoretical system and the criteria by which they can be adjudged to be refutable by empirical test. Thus, the problems associated with determining the "degree of confirmation" will not be further considered.[4]

For our purposes a general law will be taken to assert the following type of regularity: for every occurrence of a particular kind of event 0 during a definite spatio-temporal interval a specific kind of event E will occur at a place and time that is related in a specified manner to the place and time of the occurrence of the event 0.[5]

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[4] For an analysis of the problems involved in determining whether a law is satisfactorily confirmed or not see: Rudolf Carnap, "Remarks on Induction and Truth", Philosophy and Phenomenological Research, Vol. 6, 1946, pp. 590-602; and Karl R. Popper, op. cit., Ch. 10.

[5] The reader will note that we have made no attempt to include statements containing probabilistic elements in our definition of a general law. This is not because they are not interesting or useful formulations, but because we have elected to treat the special problems incurred with the use of probabilistic hypotheses at a later point in this essay.

B Explanation

Since general laws relate, in a specified manner, the occurrence of one specific kind of event to another, they are used to connect specific events into particular patterns that are referred to as "explanations". When explaining the occurrence of a particular kind of event E, the customary procedure is to point to a list of factors O_1T_1, O_2T_2, $\ldots$, O_nT_n that are said to have determined the occurrence of $E\,T$. By asserting that this particular set of events O_1T_1, O_2T_2, $\ldots$, O_nT_n caused (or determined) the particular event $E\,T$ we are actually asserting that there is at least one general law that relates events of kind O_i to events of kind E in a known and testable manner.[6] By restating this in a more rigorous manner we can see that the "scientific explanation"[7] of the occurrence of the event E consists in:

(1) A set of statements that assert the occurrence of specific events O_1T_1, O_2T_2, $\ldots$, O_nT_n.

(2) A general law or set of general laws stated in such a fashion that:

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[6] Throughout the following discussion the set of events O_1, O_2, $\ldots$, O_n and E are assumed to have occurred at particular places and time periods. Hence the notation O_1T_1, O_2T_2, $\ldots$, O_nT_n and $E\,T$ is used where T refers to the place and time during which the events O_i and E occurred. The symbols O_1, O_2, $\ldots$, O_n and E refer to the kinds of or properties of the events under consideration.

[7] The term "scientific explanation" has no honorific connotations. It is employed to distinguish the type of explanation presented in this essay from teleological, and other types of explanations found in scientific literature. In the remainder of this paper the terms "scientivic explanation" and "explanation" will be used interchangeably.

(i) both the general laws and the statements concerning the events $\underline{0}_1 \underline{T}_1, \underline{0}_2 \underline{T}_2, \ldots, \underline{0}_n \underline{T}_n$ are subject to confirmation by empirical test,

(ii) both the general laws and the statements $\underline{0}_1 \underline{T}_1, \underline{0}_2 \underline{T}_2, \ldots, \underline{0}_n \underline{T}_n$ are satisfactorily confirmed by empirical evidence,

(iii) the occurrence of the event $\underline{E} \underline{T}$ can be logically deduced from the conjunction of the general laws and the statements asserting the occurrence of the events

$$\underline{0}_1 \underline{T}, \underline{0}_2 \underline{T}_2, \ldots, \underline{0}_n \underline{T}_n.$$

For an explanation of a particular event in the physical sciences the statements in (1) would correspond to the statements specifing the initial and boundary conditions from which with the aid of the general laws contained in (2) the final event $\underline{E} \underline{T}$ can be deduced. To further clarify what is meant by an explanation of an event consider the following illustration:

The event that we wish to explain consists in the cracking of a container of water when it is left in a refrigerated enclosure over night. In this case, the statements described in (1) may be given by these observations: a container, with a securely fitting top, is filled with distilled water. The container is then placed within a special enclosure and left there over night. The temperature inside the enclosure is kept at $15^{\circ}F$ and the air pressure is observed to be normal. The pressure required to burst the material of the water container is a

certain number of pounds per square inch. Now the statements in (2)
would be "empirical laws"[8] of the following sort: A quantitative
law relating the change of the pressure of water to its temperature and
volume. A law stating the temperature at which distilled water freezes
given normal atmospheric pressure. And a law stating how the pressure
of a mass of water behaves when the volume is not allowed to increase and
the temperature is lowered sufficiently to allow the water to freeze.

From the initial and boundary conditions and the empirical laws
the cracking of the water container during the night can be logically
deduced. All the requirements for an explanation of the event have been
fulfilled. And it can be said that a scientific explanation of the
cracking of the water container has been established.

While this illustration may appear quite obvious to some readers
there are several important points that should be noted:

> (i) The system consisting of the water container and the
> refrigerated enclosure can be considered, for the purposes
> of this explanation, to be a closed system. Ideally the
> list of relevant initial and boundary conditions can be
> stated exhaustively.

8/ The term "empirical law" is used to identify general laws that are
considered to be satisfactorily confirmed by empirical evidence.

(ii) The laws are universal and conditional statements that can

be subjected to empirical confirmation independently from

their use in the particular explanation given above.

(iii) The statements containing the initial and boundary conditions

describe the occurrence of events of certain kinds ($\underline{0}_1$, $\underline{0}_2$, ...,

$\underline{0}_n$, $\underline{E}$) at certain particular spatio-temporal locations

$(\underline{tau}_1, \underline{tau}_2, ..., \underline{tau}_n, \underline{tau})$

($\underline{tan}_1$, $\underline{tan}_2$, ..., $\underline{tan}_n$, $\underline{tan}$).

Point (iii) is particularly important. There is a significant

difference between trying to establish an explanation for an event that

is described by reference to its properties and its spatio-temporal

position rather than for an event that is described solely in terms of

the time and place in which it occurred. In the former case the

explanation of the event is established, as we have seen, by deducing

the occurrence of the event in question from the conjunction of the

initial and boundary conditions and the relevant general laws. But, in

the latter case we are confronted with the problem of trying to

establish an explanation for a particular event that is described solely

by reference to the time and place in which it occurred. To develop

an explanation for such an event the statement of initial and boundary

conditions would have to include all the properties of the object

involved as well as those of the spatial region that it occupied for the

duration of the event under consideration. The impossibility of such a

task is readily apparent if we consider the problem of trying to extablish

explanations for events such as: a particular fall in the prices of certain securities on the stock market, fluctuations in the price of gold in London during a particular time interval, the collection of commodities that are sold by a department store during a particular shopping day, or any one of an indefinitely large number of individual events. This is not to say that a description of what occurred at a particular time and place cannot be made more inclusive and detailed, but rather that it is not possible to establish a scientific explanation for an event that is described solely in terms of its spatio-temporal location.

From this discussion it is apparent that it is possible to determine whether any given explanation is a scientific explanation or not. It is evident that one of the principal criteria is that the laws or hypotheses[9] employed in the explanation be both of universal form and empirically testable. Another is that at least one of these laws must be an empirical law--that is, a law well confirmed by empirical evidence--and further that the initial and boundary conditions must be stated in observational terms.

The testability requirement does not imply that each hypothesis in the theoretical structure be directly and independently refutable by empirical test. To insist on this criterion would imply, as we have seen,

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[9] In the remainder of the discussion the term "hypothesis" will be used as an equivalent of the term "general law". Hence, the term "empirical hypothesis" will be taken to be equivalent to the term "empirical law".

that all general laws containing theoretical concepts would have to be rejected. Such a position would seriously undermine a number of theoretical structures. Under this rule we would automatically have to reject such concepts as Schreodinger's ψ function in wave mechanics, as well as all the concepts of the theory of demand examined in the last chapter. Clearly this is not an acceptable procedure. The problem is resolved by allowing (as in the case of the empirical analysis of concepts) the testability of the hypothesis containing theoretical concepts to be determined by the testability of the empirical hypotheses that are deducible from them. If these procedures are followed the testability of the theoretical hypotheses is ensured and they may be employed in the establishment of scientific explanations.[10/]

C Prediction

The term prediction is usually employed to denote statements which assert the occurrence of an event, or set of events. The assertion of the occurrence of an event, say $\underline{ET}$, is usually arrived at by deducing $\underline{E}\ \underline{T}$ from the statement of some initial and boundary conditions $(\underline{O}_1\ \underline{T}_1,\ \underline{O}_2\ \underline{T}_2,\ \ldots,\ \underline{O}_n\ \underline{T}_n)$ and the appropriate general laws. Thus, the logical structure of a scientific prediction is similar to that of a

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10/ The term "testability" is employed to denote the ability of the hypothesis or theory to stand up to--that is, not to be disconfirmed by-- a series of empirical tests.

scientific explanation. And the function of the general laws is the same in both cases.[11/] The two are distinguished by the fact that in prediction we infer a statement about the occurrence of an event $E\ T$ before we examine whether it has occurred or not, while in an explanation it is the known occurrence of the event $E\ T$ that we wish to explain.

In science the prediction of an event is frequently used as an empirical test of one or more of the general laws in a theoretical structure. If the predicted event fails to occur, under the specified conditions, then at least one of the general laws is said to be dis-confirmed. If the event does occur the law or laws are said to have passed an empirical test and their "degree of confirmation"[12/] is raised.

11/   To emphasize the logical similarity between explanation and prediction Reichenbach called them "postdictability" and predictability": see Hans Reichenbach, Philosophical Foundations of Quantum Mechanics, University of California Press, 1944, p. 13. It should be noted that these points will be further discussed when we examine probabilistic explanations and predictions in the next chapter.

12/   While a discussion of the various procedures for determining the degree of confirmation go beyond the scope of our analysis, the following quotation may serve to illustrate the meaning of the term.

"We cannot verify the law, but we can test it by testing its single instances i.e. the particular sentences which we derive from the law and from other sentences extablished previously. If in the continued series of such testing experiments no negative instance is found but the number of positive instances increases then our confidence in the law will grow step by step. Thus, instead of verification, we may speak here of gradually increasing confirmation of the law."(R. Carnap, "Testability and Meaning, " Philosophy of Science, Vol. 3, No. 4, 1936, p. 425).
The term "degree of confirmation" is defined and discussed in Carl G. Hempel and P. Oppenheim, "A Definition of 'Degree of Confirmation'," Philosophy of Science, Vol. 12, No. 2, 1945, pp. 98-115.

It should be noted that the strict disconfirmation of a law or laws can only occur under the following conditions:

    (i)   At least one of the laws in the relevant theoretical structure is empirically well confirmed.

    (ii)   The system under investigation can be considered, for the purposes of the predictive inference and the subsequent analysis, to be free from any significant external disturbances.

If under these conditions the predicted event does not occur then we can conclude that at least one of the general laws contained in the theory has been disconfirmed. In cases where it is either very difficult or impossible to tell whether significant disturbances have occurred or not, it is no longer possible to strictly disconfirm a law. However, unless the first condition is met it is not possible to disconfirm any of the laws and hence the theoretical system cannot be considered to be a part of empirical science.13/

2. Explanation and Prediction in the Theory of Demand

In the preceding section we have outlined and deliberately emphasized the basic requirements for a scientific explanation. We now intend to examine the theory of demand to see whether the explanations of economic events offered by this theory conform to these requirements.

13/ This point will be discussed at greater length in Chapter VI.

A <u>Testing</u> <u>the</u> <u>Postulates</u> <u>of</u> <u>Utility</u> Theory

Before we examine the explanations of economic events offered by
the theory of demand we must first be sure that the theory itself is
open to empirical investigation--that is, we need to make sure that
there is at least one law or hypothesis within the theoretical structure
that is empirically well confirmed.

In the previous chapter we saw that if the concepts of the theory
were to be subjected to empirical analysis then the four basic postualtes
must be shown to be empirically ture. If these postulates can be evinced
to be well confirmed, then they will perform for us two vital functions.
First they will provide the concepts of the theory with the desired
empirical content. And second, having been confirmed by empirical tests,
they would in turn become the empirical laws that are required to form
the basis for the theory's testability. Thus, if these postulates can
be demonstrated to be empirically true the concepts as well as the
theory become testable and, in principle, meet the requirement that
they are subject to the process of refutation by empirical test.

If the basic postualtes of utility theory are to be accepted as
empirical laws, then, as we have seen, ~~they must be stated~~ it must be possible to state them in the universal
and conditional form. Under these conditions the four basic postualtes
noted in Chapter III are now to be tested as conditional statements that
apply to the behavior of all consumers. In order to see what this
requirement entails let us re-examine for a moment these four postulates
stated explicitly in the conditional form.

P_1: If the consumer is confronted with all possible pairs of alternatives A and B, then he can state whether he prefers A to B, or B to A, or whether he is indifferent between them.[14]

P_2: If the consumer is confronted with a pair of alternatives A and B, then he can state unequivocally whether he prefers A to B, B to A, or whether he is indifferent between them.

P_3: If the consumer is confronted with three possible alternatives A, B, and C, and the consumer states that he prefers A to B and B to C, then he will prefer A to C.

P_4: If the consumer is required to select a combination of commodities from those that are available to him, then he will select that combination that yields him the highest utility.[15]

14/ It should be noted that alternatives A and B each entail some combination of commodities at their respective prices. In order to include the notion of choice among uncertain prospects A and B can be taken to represent certain combinations of lottery tickets. In this case the consumer's behavior must conform to slightly different postulates. But most of the essential requirements are contained in the postulates treated above and the special conditions of the Von Neumann-Morgenstern postulates will not be treated here.

15/ In the case where uncertain prospects are involved this postulate is satisfied if the consumer is shown to maximize the expected value of his utility.

Having stated the postulates in this form it is now necessary to decide upon the type of evidence that will be considered to provide an adequate set of empirical tests. In other words are we to interpret these postulates as referring directly to the behavior of individual consumers, a statistically "average" consumer, or only to an "ideal" consumer who is not expected to have any precise counterpart in "real" life?

If we adopt the last position--that is, consider only the behavior of an "ideal" consumer to be regulated by these four postulates--then we need to have a set of instructions or interpretative rules that tell us how to apply the "ideal" laws to the data of a particular case. For example, earlier in this chapter we made use of the physical law relating the free fall of a body near the earth's surface as an illustration of what was meant by a universal statement in conditional form. Now this law was formulated to be, and in fact is, an idealization of the behavior of freely falling bodies near the earth's surface. This "ideal" law is supposed to be true only for bodies falling in vacuo when near the earth's surface. Since it is not possible to measure the free fall of bodies in a perfect vacuum various interpretive rules must be set out so that the law can be tested by observing free fall of bodies in the atmosphere. In this case the interpretive rules consist of a set of instructions that identify the factors to take into consideration e.g. the density of the media, the shape of the object, etc. as well as the effect that these factors will have on the results. [16]

If we consider our postulates in this manner, e.g. as "ideal" laws, we still need to decide whether the data we wish to test the postulates against should be generated by individual consumers or by a statistically "average" consumer. Since the postulates as stated above can be construed to refer to the behavior of individual consumers, let us first consider the problem of testing these "ideal" laws against the behavior of particular consumers.[17] In order to perform these tests, what are our interpretive rules going to be? Neither utility theory nor the theory of demand provide us with much in the way of interpretive rules. The Von Neumann-Morgenstern approach enables us, under very special circumstances, to calculate the utility a particular consumer ascribes to a given selection of lottery tickets. But what about the consumer who is faced by the more common task of selecting his purchases from a wide range of commodities? For example, if we are to be able to test the "ideal" laws against the behavior of a consumer we must have some means

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16/ cont. It should be noted that the natural sciences frequently use this technique for formulating laws which hold true only in "ideal" cases. Almost all the well known physical laws are formulated under such conditions. Thus, as long as a set of interpretive rules exists these laws can be tested against actual instances and the data employed to confirm or disconfirm the general laws.

17/ The author is aware of the fact that many economists agree with Hicks when he states that, "To assume that the representative consumer acts like an ideal consumer is a hypothesis worth testing; to assume that an actual person, the Mr. Brown or Mr. Jones who lives around the corner, does in fact act in such a way does not deserve a moment's consideration." A Revision of Demand Theory, op. cit. p.55. But, since few reasons are ever given why this should be so, and since the theory of demand is frequently alleged to pertain to individual consumer behavior, a consideration of the problems involved in testing the "ideal" laws against individual behavior should not be left out of our analysis.

of determining that, the consumer's preference orderings remain the same throughout the series of trials in which we observe his choice behavior. But the theory does not provide us with a means for determining the preference orderings before the experiments begin. On the contrary, the theory only allows us to glean information about his preferences _after_ he has made his selections. This fact is amply demonstrated by the approach used in the Theory of Revealed Preferences. Unless we have some independent information on the way in which a consumer's tastes alter over time we are unable to conclude very much from the data that would be generated from a series of empirical tests. It could be argued that we should assume that preferences remain the same over brief intervals of time, and conduct the test within these intervals of time. But this would not solve the problem at all. We would still have to be able to demonstrate by some alternative technique that his preferences did in fact remain unchanged during these intervals of time. For example, the problem can be stated in the following way:

If preferences are constant, then we can use the data from various trials to test the "ideal" laws. Restating this in our simplified logical notation we have $\underline{P}_t \to \underline{D}_t$, where $\underline{P}_t$ represents a statement about the constancy of a consumer's preferences during a specified interval of time, and $\underline{D}_t$ a statement about the data that is generated from the empirical tests.

From our discussion in Chapter II it is evident that even if the

empirical data to fire the statement $\underline{P}$, we cannot employ this result to

infer the empirical truth value of $\underline{P}$. This is a very very important

point. It implies that it is not possible to use the data from one set

of trials to confirm the truth values of both the major and minor premises

of a particular expression. If we had an independent method of testing

the truth value of $\underline{P}_t$, then we could employ the data from a set of

trials to confirm or disconfirm the expression $\underline{P}_t \Rightarrow \underline{D}_t$. But an independent

test for $\underline{P}_t$ is not provided by utility theory or the theory of demand.

Consequently, we can conclude that to be able to test the "ideal" laws

against individual behavior we first need to have an independent means of

determining a consumer's preferences as well as the way in which they alter

over time.

Since the interpretive rules are not sufficient to allow us to

confront the "ideal" laws with individual behavior we shall now examine

whether they are sufficient to allow us to confront the "ideal" laws

with "statistically" average behavior. In this case there is an

abundance of data to draw on. Representative, or statistically average,

patterns of behavior can be collected by gathering data on the behavior

of a large number of different groups, purchasing the same or difference

commodities. However, it does not appear that this abundance of data

facilitates the testing procedure in any way.

Consider the following example: Data is collected on the purchases

of a particular commodity by the consumers of a specific region, and we

now went to use this data to test our "ideal" laws. Presumably the one
law that we would like to establish is that these consumers are consistent
in their choices and show no tendencies toward violation the transitivity
requirement. But before our data could tell us anything about the
transitivity of their selections we would first need to know something about
their preference scales. If this group of consumers is composed of
individuals who are identical in every way (by this we mean that they
must have identical tastes, as well as incomes) then each consumer's
preference scale is exactly the same, and the group's preferences are given
by a direct summation of the preferences of all the individuals. Except
for scale factors, the group's indifference curves would be identical to
each individual's. Under these conditions the data on the group's
purchases could then be viewed as representing each individual's purchases
and we would be ready to begin our tests. But, if we use this data to
establish the preference scales, which clearly must be done prior to
examining whether the preference orderings are consistent or not, we are
manifestly in the same predicament as we were in our previous example.

Unless preference orderings can be established prior to and independently
of the collection of the data it is meaningless to examine the data with
the hope of both establishing the preference orderings and of using
these orderings for an empirical test of the "ideal" laws. For example,
assume for the moment that we have been able to collect data on the
purchases of a particular group of consumers. These consumers have
identical tastes and incomes so that the indifference curves for the group
differ only by a scale factor from the indifference curves of each

member of the group. Also, assume that our data reflect only the
purchases of commodities made by this group during a particular period of
time. Accordingly, the data will consist of an itemized list of foodstuffs
giving the amount purchased of each at its prevailing price. Now,
we can use these data to establish some kind of preference scale for
these consumers for their particular selection of edibles. We can
observe which items were selected and which were ignored from the list of
available commodities. But, what we cannot do is to use the same
collection of data to declare that the preference scale is consistent,
that all alternatives were rank ordered prior to the selection taking
place, and that the group chose that set of comestibles that yielded them
the highest utility.

To be able to employ these data to draw this set of conclusions we
would need to have some independent method of establishing the group's pref-
erence ordering for all the available commodities prior to their selection
of a particular set of goods. That is to say, we would need to know, before
they made their selections, precisely which items should be selected and
which should be avoided if their selections are to be consistent with
their preference scale. But the only available data are the data generated
by their actual selections. And these data are simply not sufficient
to both determine and adjudge the preference orderings.

To further illustrate this point let us take the case of the binary
choice experiment since it has frequently been used in empirical investi-
gations of utility theory. In this experiment the subject is required to

choose one of two possible symbols in each of a fairly long series of
trials. When he has selected a symbol, say a plus or a minus sign, he
is told whether he was "right" or "wrong". "Correct" choices are
determined by the experimenter, and these may conform to a random series
of digits or they may fit a definite pattern. In either event, suppose
that the "pluses" appear three-quarters of the time, determined at
random while the "minuses" appear on the remaining one-quarter of the
trials. If we are testing the subject to see whether his behavior
conforms to the Von Neumann-Morgenstern postulates, we will want to
know whether the subject maximizes his expected utility or not. In this
example a subject maximizes his expected utility by choosing "plus" on every
single trial. By this technique he would be correct three-quarters of
the time which is a better score than he could expect to achieve by any
other strategy. Hence, by observing a subject's behavior we can immediately
tell whether he is or is not maximizing his expected utility and
consequently whether his behavior conforms to the basic postulates of
behavior or not.

What is there about this experiment that differs from our
previous examples? For in the binary choice experiment it appears that
we can indeed tell from the evidence of the experiment whether in fact
the subject's behavior conforms to the basic postulates or not. The
difference lies in the simple fact that in the case of the binary
choice experiment we know precisely what behavior patterns will conform
to the basic postulates. Furthermore we have this knowledge prior to
and independently of the evidence from any particular experiment. In our

earlier examples we cannot have this knowledge. And, we can not tell
beforehand exactly what behavior will conform with and what behavior
will conflict with our "ideal" laws. As a result the evidence from any
particular set of observations of consumer behavior can only tell us
something about their preference structure. And unless we already
know what it means in that particular situation to maximize utility
(whether expected utility or not) the data cannot be used to disconfirm
the postulates or laws of behavior. If the theory of demand contained
interpretive rules that prescribed various sets of behavior to be
consistent, in certain situations, with its "ideal" laws, then one
could proceed to observe the behavior of individuals and groups and
conclude from these observations whether the laws were confirmed or not.
But until such interpretive rules are specified it is simply not
possible to observe the purchases made by particular groups of consumers
and use this data to empirically confirm or disconfirm the "ideal" laws
of consumer behavior.

That this state of affairs should be so becomes even more apparent
if we take our data from a group of actual consumers who, as is almost
inevitably the case in any real sample of data, differ in their tastes,
their incomes, and their preference scales. In this case the data of the
group's purchases do not reflect directly the preferences of each member
of the group. Instead the data are some aggregation of their preference
scales. To proceed to use this data to test the "ideal" laws is simply
impossible since the theory of demand gives one no rules for interpreting

the behavior of assumed preference scales. The only possible approach
is to view this data as being generated by some "representative"
consumer. But to do this is to place the problem in exactly the same
predicament as before. The data can tell us which commodities this
"representative" consumer actually chose. And the theory cannot tell
us which commodities he should have chosen. To be able to do so the
theory would have to have a large number of interpretive rules so that
in each case the experimenter could determine the set of behavior
patterns that would be consistent with the "ideal" law. Without these
rules the "ideal" laws of behavior cannot be tested. Thus, the theory of
utility must be classified as an uninterpreted theoretical structure
that is incapable of being refuted by empirical test.

B Testing the Theory of Demand

In the previous section we have shown that the basic postulates of
utility theory cannot in their present state, be empirically confirmed.
Consequently, the theory of utility is not refutable by empirical test.
Since the concepts of the theory of demand depend for their empirical content
on the empirical validity of utility theory it would appear that the
theory of demand is also not subjectable to a process of empirical
confirmation. This conclusion is perfectly sound if the theory of
utility, and its basic postulates, represent the only possible source
of empirical content. If this is in fact the case, and our analysis in
Chapter IV seems to indicate that it is, then on the basis of our
analysis so far we can conclude that the theory of demand is also an
uninterpreted theoretical structure incapable of producing explanations

and predictions of economic events.

But, before we can accept this conclusion we must first examine the theory of demand in more detail to see whether it does not have its own sources of empirical content. If empirically testable relations can be discovered, then the theory of utility can derive its empirical content from the theory of demand. If this can be shown to be the case, then the non-testability of the basic postulates of utility theory will no longer prevent the theory of demand from being empirically confirmed.

To ascertain whether the theory of demand does in fact contain testable empirical relations we must abandon our examination of the basic postulates and instead focus our attention on the testability of the derived laws. Since the theory of demand has one major consequence this implies that we must now turn our attention to the demand functions themselves or what is sometimes called the law of demand.

As noted earlier, the demand function for the _ith_ consumer, for commodity x_j, is expressed in terms of the prices of all other commodities and his income. This is represented by the expression:

$$D_{ij}(x_j) = f_{ij}(p_1, p_2, \ldots, p_n, y_i)$$

This function is expressed in terms of the _ith_ consumer's demand for a certain commodity x_j. But since we have already seen the type of difficulties that are encountered when the behavior of particular individuals is considered let us first examine the case where the demand function is rewritten so that it represents the demand for commodity x_j

of a particular group of consumers. From various empirical studies of

demand it is clear that a group demand function can be constructed. This

demand function represents and defines the purchases of x_j as a function

of the prices of the other commodities available and the group's income.

It has also been shown that in most cases the demand function will have

a negative slope and its other properties will closely approximate those

discussed in Chapter III.[18/] The question that must now be answered is

whether or not this empirical relation represents a general law that has

the standard universal and conditional form. If it does we have

succeeded in our search for an empirical law. If it does not we

must conclude that the theory of demand is not empirically testable

as there are no other empirical relations left to examine.

But to return to our empirically determined demand function. Can

we show that it is one example of the general law of demand? To be able

to do so will require us to show that certain properties of this law are

universally true. One of these properties is that demand curves are

always drawn with negative slopes. But empirical studies have

discovered cases where the slope of the demand curve for a particular

commodity is positive. Hence, if we are to take the negative slope as

a universal property of demand curves we must have a technique for

identifying and excluding those commodities for which demand curves have

a positive slope. Now in Chapter III, we saw that the slope of the demand

18/ For particular examples of demand curves see the results presented
    by H. Schultz, The Theory and Measurement of Demand, University of
    Chicago Press, 1938; and for an excellent review of more recent
    research see: R. Ferber, "Research on Household Behavior,"
    American Economic Review, Vol. 52, March 1962, pp. 19-63.

curve--that is, the rate of change of the quantity of X demanded with respect to the price of X--was given by the Slutsky Equation.

$$\frac{\partial X}{\partial P_X} = (\frac{\partial X}{\partial p_X})U = const. - x \frac{\partial X}{\partial y} Price = const.$$

Further, it was pointed out that the term $(\frac{\partial X}{\partial p_X})U = const.$, the Substitution Effect, was always negative. From this it follows that $\frac{\partial X}{\partial P_X}$ is also negative unless the value of the Income Effect is such that $\left| - x (\frac{x}{y})Price = const. \right| \geq \left| (\frac{x}{p_X})U = const. \right|$. As a result, if we can identify those commodities for which a rise in price will induce a large and positive income effect, then we can place them to one side and state that our law of demand applies to all other commodities but those. However, the only means given to us by the theory of demand for identifying these special commodities is to note whether the slope of the demand curves is positive--that is, whether $\left| - x (\frac{\partial x}{\partial y})Price = const. \right| \geq \left| (\frac{\partial x}{\partial p_X})U = const. \right|$. Since the Substitution Effect, $(\frac{\partial x}{\partial p_X})U = const.$ cannot be directly observed, it is not possible to independently measure its size, even if it were possible to directly measure the income effect. Thus, the slope of the demand curve for a particular commodity can only be discovered by observing the purchases made by a particular group of consumers. Also, since we cannot state that the preferences and tastes of consumers do not change over time it is not possible to state that the demand curve for a particular commodity will always have a positive slope. If we cannot identify the commodities for which the law

of demand does not imply prior to and independently of an empirical

test of the law then, as we have seen above, it is not possible to

empirically disconfirm the law. For example, all the evidence that is

collected in demand studies either agrees with the law--that is, the

demand curves have a negative slope--or if the slopes are positive, then

this result merely identifies at that point in time, those commodities

to which the law does not apply. Therefore, the empirical studies of

consumer demand can only support the law, never disconfirm it.

Moreover, if the basic postulates of utility theory were empirically

confirmable then one could investigate the preferences and tastes of

consumers and ascertain to what degree preferences for commodities

changed with time. But the theory of utility does not provide

sufficient interpretive rules to allow such conclusions to be drawn.

Hence, we have no evidence to suggest whether a particular demand relation

that exists at one period of time will continue to exist at some other

period of time, even for the same group of consumers. For example, a

particular demand function can be constructed for a particular set of

commodities and prices during a specific time period. But if this

demand function were then to be used during a different period of time

to predict the amount purchased at a new price of the same commodity, the

failure of this prediction could not be used to disconfirm the law.

Unless we have independent evidence which strongly suggests that the

relevant conditions--this is, those encompassed by the ceteris paribus

conditions--have remained unaltered during the interval of time
between these events, it cannot be argued that the parameter values
determined during one period of time will apply to another.[19]

In this discussion we have taken the negative slope as one of the
major properties of a demand curve. We could also have examined whether
all demand functions were homogeneous of degree zero. But if we cannot
establish the negative slope as a universal property of demand curves
there is no point in pursuing our investigation of the other properties
any further. For if demand curves can have negative, positive, or
possibly zero slopes, it does not help us establish an empirical law of
demand to know whether they are homogenous of degree zero or not. Indeed
the property of homogeneity can only be established after the law of
demand has itself been empirically established. Thus, until it is
possible to independently identify those commodities that are beyond
the purview of the law; and until it is possible to demonstrate that a
demand relation which exists at one period of time also holds at another
period of time; it is not possible to empirically establish the law of
demand. If we cannot establish the law of demand as an empirical

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19/ Emile Grunberg in his paper, "Notes on the Verifiability of Economic
Laws," Philosophy of Science Vol. 24, 1957, pp. 337-348, points out
this difficulty in the following manner: "Sometimes the explanation
of a unique event is said to make possible the prediction of a
subsequent event. Let those events be E and E' respectively. Closer
examination reveals that--regardless of whether there is an explanation
of E--the prediction of E' simply uses observable attributes of E as
initial conditions. Likewise the set [of general laws] L' used in
the prediction of E' is independent from the setL which might be used
in the explanation of E." (p. 339)

generalization then it follows that the theory of demand is virtually
devoid of empirical content. Therefore the theory of demand, like the
theory of utility, must be classified as an uninterpreted theoretical
structure that is incapable of being refuted by empirical test.

C Explanations and Predictions with the Theory of Demand

In the first section of this chapter we deliberately emphasized
the point that it was not possible to construct a scientific explanation
for the occurrence of an event unless at least one of the general laws
contained in the explanation was an empirical law. In the following
sections we examined the theory of utility and the theory of demand and
discovered that both of these theories were uninterpreted theoretical
structures and did not contain an empirical law. Thus, it is clear that
the explanations of economic events that are offered by these theories
cannot be scienfific explanations. How then can we characterize them?
To assist in our analysis of this question we shall make use of the
following example of what would be a scientific explanation of an
economic event.

Let the event to be explained E T be an increase in the amount
purchased, during a certain time period, of a particular commodity X_i
by a specified group of consumers living in a particular geographic region.
In order to establish an explanation for this event we need to state the
initial conditions and the general laws from which an increase in the
demand for X_i can be deduced. The initial and boundary conditions could

be given by the following observations: Commodity X_i is one of a number
of commodities that are frequently purchased by the group of consumers
under consideration. The prices and quantity consumed of all the
commodities are known and it is observed that the price of commodity X_i
has recently been lowered. Further it is observed that these consumers
regularly spend a certain percentage of their total income on these
types of commodities. Now the set of general laws would consist of the
following: A quantitive law relating the quantity purchased of commodity
X_i to the prices of the other available commodities, as well as the
percentage of the group's total income that is spent on these commodities.
A law specifying precisely how consumers should act so as to maximize
their utility from their purchases of available commodities.

From the initial and boundary conditions and these general laws an
increase in the amount of X_i purchased could be logically deduced.
Further if we had been asked to predict the change in the amount of X_i
purchased, prior to seeing whether the demand had actually increased, we
would have been able to do so from a listing of the initial and
boundary conditions and a statement of the relevant general laws.

In the previous sections we have pointed out that it is not possible
to construct this type of an explanation from the currently accepted theory
of demand. That it is not possible to do so is clear since neither the
theory of utility nor the theory of demand contains the requisite empirical

laws. However, events such as the one described above are frequently explained by economists in a manner that is quite similar to that which we have pursued in our example. The principal difference, between the scientific and the "economic" explanation is that the explanatory schemata of the latter cannot be used to generate testable predictions. Thus, it can only take the form of what we shall call an "explanatory rationalization" of the event after it has occurred. For example, the functional relation between price and the quantity purchased of X_i can be empirically determined only by observing the purchases that are actually made. Also the preferences and tastes of consumers can be determined only after they have decided which commodities to purchase out of the total number available to them. In a similar manner the reaction of consumers to a rise in price can be empirically determined only after the event has occurred. And except in the most simple of cases[20] it is not known either before or after the event whether the consumers have in fact maximized their utility or not.

"Economic" explanations, then, are ex post facto rationalizations of the occurrence of the event under consideration. That is to say, the theories of utility and demand are sufficient to provide after-the-fact rationalizations of why an event occurred. But, as we have shown they are not sufficient to produce an explanation of an event before it has occurred. In keeping with Papandreou's analysis[21]

20/ Binary choice and other similar experiments.

21/ A. G. Papandreou, op. cit. p. 139.

we shall classify this type of explanation as an ex post facto
explanatory scheme. Hence, we can conclude that until interpretive
rules are discovered which permit general empirical laws to be developed,
the explanations of consumer behavior offerred by the theory of demand
will remain ingenious rationalizations that can be classified under
an ex post facto explanatory scheme.

CHAPTER VI

THE ECONOMIST'S DILEMMA

In the previous two chapters we have submitted the theories of
utility and demand to a fairly extensive examination. From our
analysis of the function of their concepts and laws we have been led to
the conclusion that neither the basic postulates nor the derived laws
can be subjected to a process of refutation by empirical test. As
we have seen, this implies that the theory of demand lacks empirical mean-
ing and, therefore, cannot be employed to establish scientific explanations
or predictions of consumer behavior. Since the theories of utility and
demand play an important role in the formulation of a large part of
micro-economic theory it would appear by direct implication that many
other parts of micro-economic theory are also not refutable by empirical
test. If this is in fact the case then this conclusion suggests that
it is perhaps the economist's methodology that is at fault. Since the litera-
ture is somewhat replete with statements on how economists should go about
their business of developing economic theory the object of this chapter
is not to increase by the number of articles devoted to this task.
Rather it is our purpose to re-examine the basic problems encountered in
trying to subject the theory of demand to empirical test. And from this
investigation try to ascertain to what extent the methodological devices
used by economists are responsible for this absence of predictability.

1. Prediction as the Criterion of Empirical Validity

As noted in the introduction, the history of economics is in part
a history of a debate over the criteria that should be employed to
adjudge the empirical validity of economic theory. This debate has
primarily centered upon the basic postulates (or assumptions) of
micro-economic theory. On one side it has been held that the truth
value of the micro-theories should depend upon the empirical reality of
the assumptions. Other economists were of the opinion that it did not
matter whether these assumptions were descriptively realistic or not
since at best they had to consist of abstractions from actual behavior.
Their concern was only whether these abstract assumptions were
sufficiently good approximations to observable behavior to serve as a
reasonable basis for the theoretical constructions.[1/] More recently it
has been argued that, "Its [positive economics] task is to provide a system
of generalizations that can be used to make correct predictions about
the consequences of any change in circumstances. Its performance is to
be judged by the precision, scope, and conformity with experience of
the predictions it yields."[2/] Further, the debate over the reality of the
assumptions is misconceived in that, "...the relevant question to ask about

1/ Comments on this dispute can be found in the writings of J. S. Mill,
Essays on Some Unsettled Questions of Political Economy, (London School
of Economics and Political Science, Reprint No. 7, 1948) especially pp. 143-149
and excellent examples can be found in the literature on the "marginalist
controversy" in the American Economic Review, Vols. 36-38, March 1946-June, 1948

2/ Milton Friedman, Essays in Positive Economics, University of Chicago,
1953, p. 4. (Italics added)

the 'assumptions' of a theory is not whether they are descriptively
'realistic', for they never are, but whether they are sufficiently
good approximations for the purpose in hand. And this question can be
answered only by seeing whether the theory works, which means whether it
yields sufficiently accurate predictions. The two supposedly independent
tests thus reduce to one test.[3] While this position is one which few
economists appear willing to quarrel with let us examine for a moment the
implications of this criterion and the manner in which the prediction of
an event is frequently employed in micro-economic analysis.

A   Implications of the Prediction Criterion

In the preceding chapter we briefly examined the function of general
laws in the prediction of an event. We pointed out that their role in a
predictive inference was similar to their function in a scientific
explanation. Also it was noted that the prediction of an event was
frequently used as a means for subjecting a theory to a process of
empirical confirmation. At this point, however, we wish to examine
the logical structure of a prediction so that we can be in a better
position to judge whether the successful prediction of an event is a
sufficient criterion with which to judge the empirical truth value of
micro-economic theory.

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3/ Ibid, p. 15.

To facilitate this analysis we shall employ the notation employed in
Chapter II, Section 2, where the letters P, Q, R, S, are the names of
variables in our metalanguage of deductive systems. If we let A and B
be the names of the basic postulates (or assumptions) of a particular theory
(an applied deductive system), and C the name of a general hypothesis
that can be inferred from A and B, then we can let D be the name of a
hypothesis that is inferred from the basic postulates and the hypothesis C.
If we then let the variables of the metalanguage correspond to these
statements in the object language we can represent this sequence of
inferences as follows:

$$P \cdot Q \to R$$

(from P and Q we can infer R)

and

$$(P \cdot Q \to R) \to S$$

(from the expression $P \cdot Q \to R$ we can infer S)

Now let us suppose that we wish to test this theory by predicting the
occurrence of an event and observing whether it does in fact occur in the
prescribed manner. Furthemore let our deduced law (or hypohtesis) S
be the predicted inference against which we shall compare the actual
observations. Assume that the test is conducted, the event is observed, and we
now examine whether the data corroborate the statement S. Let us
suppose, for the moment, that the answer is in the affirmative. The
question that we wish to pose is, under what conditions does the
empirical support for S provide empirical confirmation for P, Q, and R?

For if the correct prediction of an event is to be the criterion by which we judge the empirical truth value of a theory, then we must be sure of the conditions under which there is a connection between confirmatory evidence for S and the theoretical structure composed of P, Q, and R.

In Chapter II, Section 2, we also noted that if a theory was to be considered a part of empirical science, then it had to be possible to submit the theory to a process of refutation by empirical test. Hence, if we wish to empirically confirm the expression $P \rightarrow Q$ it is not sufficient to find evidence which supports Q. P must also be shown to be empirically true before the expression can be said to be confirmed.

Returning now to our predicted inference S we can see that if we know that the empirical value for $(P \cdot Q \rightarrow R)$ is 'true', and we have data which supports S, then we can conclude that we have a confirming instance for $(P \cdot Q \rightarrow R) \rightarrow S$. In this case we could say that our theory has passed an empirical test by being able to correctly predict the occurrence of S. Conversely, if the evidence had not supported S, but we still had evidence suggesting that the empirical value for $(P \cdot Q \rightarrow R)$ was 'true', then we could conclude that the empirical value for the expression $(P \cdot Q \rightarrow R) \rightarrow S$ was 'false'. This then would be a case where the failure to correctly predict the occurrence of S would be sufficient to disconfirm at least one of the theory's hypotheses.

But now consider the case when we do not know the empirical truth value of the expression $(P \cdot Q \rightarrow R)$. Clearly, if the predicted event occurs the evidence supports the statement S. But to know only the empirical truth value for S does not allow us to determine the empirical truth value of the expression $(P \cdot Q \rightarrow R)$. Hence if we are unable to determine the empirical truth value of $(P \cdot Q \rightarrow R)$ it is clearly not possible to use the evidence supporting the statement S to confirm or disconfirm the theory represented by the expression $(P \cdot Q \rightarrow R)$.

If we have some way of empirically determining the 'truth' or 'falsity' of P and Q--that is, if P and Q happen to be empirical laws-- then we can test the empirical validity of both R and S. In this case any negative evidence will be sufficient to disconfirm them. Also it should be noted that if R is an empirical law from which S can be deduced with the assistance of P and Q, then the knowledge that the empirical value of R is 'true' is sufficient to allow the expression to be confirmed or disconfirmed by empirical test.

From this analysis it is clear that the prediction of an event can only be employed as a means of testing a theory when some parts of the theory have already been well confirmed. This result corresponds directly with the requirements set out in Chapter V for a scientific explanation--namely, that the explanans must contain at least one empirical law. Since all theoretical structures do not necessarily

contain well confirmed laws we cannot conclude that the successful
prediction of an event is a sufficient criterion by which to judge the
empirical truth value of a theory.

B Prediction and Micro-Economic Analysis

From our analysis of what we shall call the logic of prediction we
can now see that if we are to be able to use the successful prediction of
an event as confirmatory evidence then the theory itself must already
contain some parts that are empirically well confirmed. Hence, to
return to the debate over the assumptions, either the basic postulates
or some of the general laws contained in the theory must be accepted as
empirically well confirmed before it is possible to employ the evidence
of a test prediction for any confirmatory purpose.

Consider, however, the following example of a position which has
frequently been held by economists: "Consider the problem of predicting
the shots made by an expert billiard player. It seems not at all
unreasonable that excellent predictions would be yielded by the hypothesis
that the billiard player made his shots as if he knew the complicated
mathematical formulas that would give the optimum directions of travel,
could estimate accurately by eye the angles, etc., describing the
location of the balls, could make lightning calculations from the formulas,
and could then make the balls travel in the direction indicated by the
formulas. Our confidence in this hypothesis is not based on the belief
that billiard players, even expert ones, can or do go through the

process described it derives rather from the belief that, unless in some way or other they were capable of reaching essentially the same results, they would not in fact be expert billiard players."[4] In order to clarify what it is that is being said here we shall employ our logical notation. Let D be the relation between the billiard balls described by the expert making his shot. Hence, D is the event that is described by the sentence "Consider the problem of predicting the shots made by an expert billiard player." And let C be "the hypothesis that the billiard player made his shots as if he knew the complicated mathematical formulas... ." By substituting variables for these sentences the theory can now be represented by the relation $R \rightarrow S$. But, we have just seen that the existence of evidence confirming S does not establish the empirical truth value of the expression $R \rightarrow S$, unless we have prior knowledge of the empirical truth value of R. But in the passage quoted above we are asked to believe R merely because there is some evidence for S, not because we have any evidence in favor of R. In fact we are even informed that it would be highly unlikely for the empirical evidence to support R. Clearly, if we want $R \rightarrow S$ to be a testable empirical expression this approach is mistaken.

4/ This example is taken from Friedman, op. cit. p. 21 and can also be found in M. Friedman and L. J. Savage, "The Utility Analysis of Choices Involving Risk." Journal of Political Economy, Vol. 56, August 1948; p. 298 (Reprinted in the A. E. R. Readings in Price Theory, Chicago, 1952).

This is not to say that we cannot employ the procedure of assuming that the empirical value for R is 'true' and then examining the evidence in favor of S to see whether the relation $R \to S$ could be confirmed. If we find confirming evidence for S, then we know that if we can find confirming evidence for R that we will then be able to confirm the expression $R \to S$. But in the absence of any evidence pertaining to R it is evident that we cannot establish the truth value of the empirical expression $R \to S$.

To examine one further point raised by this example we shall return for a moment to the hypothesis R which is stated in the following terms.: "the billiard player made his shots as if he knew the complicated mathematical formulas...". We have already seen that if the expression $R \to S$ is to be capable of refutation by empirical test then the hypothesis R must be stated in such a way that it can be empirically confirmed. But it frequently occurs in the statement of micro-economic theories that the principal postulates or hypotheses are stated in such a way that they cannot be disconfirmed. For example, the principal hypothesis in the theory of the firm is normally stated in the following manner: "That individual firms behave as if they were rationally seeking to maximize their expected returns." Typically, the evidence produced in favor of this hypothesis is the statement that if the behavior of firms were not consistent with this hypothesis then they would probably not be in business for very long. But here we are back to the problem of trying to confirm an expression like $R \to S$ by finding some evidence in favor of S. To empirically confirm the expression $R \to S$ we

need to be able to test the hypothesis R. The inclusion of the as if clause in R does not matter as long as R is an empirically testable hypothesis. If the inclusion of the as if clause precludes the possibility of empirically testing R, then no matter how much evidence there is in favor of R we cannot conclude that the expression R → S has been empirically confirmed.

C Prediction and Probabilistic Law

Up to now our analysis of the problems involved in employing the prediction of an event to confirm a given body of theory has only been concerned with theoires that contained general laws stated in the universal and conditional form. That is to say, we have only been considering theoretical structures in which the general laws, postulates and hypohteses have the following form: for every value of x_i all instances of $P(x_i)$'s are $Q(x_i)$'s. However, not all laws are stated in this form and we shall now briefly turn our attention to the special problems that are encountered when the theoretical system contains laws, postulates, or hypotheses that are stated in probabilistic form.[5]

5/ For a considerably more comprehensive analysis--to which this section is indebted--of the problems encountered when probabilistic laws are employed see: Carl G. Hempel, "Deductive-Nomological vs. Statistical Explanation," Part II, in H. Fiegl, et. al. (eds) Minnesota Studies in the Philosophy of Science, University of Minnesota Press, 1962, Vol. III.

A hypothesis or law is stated in probabilistic form when it asserts that certain properties of various specified events are associated by a particular statistical frequency. For example, if we employ the notation given above a simple probabilistic law would be given by the following: The probability that an occurrence of $P(x_i)$ will also be an occurrence of $Q(x_i)$ is given by r, where r represents the long-run frequency of all $P(x_i)$'s being $Q(x_i)$'s. Restating this law in more common statistical notation we can represent it by the following: for all (x_i), $p\ [P(x_i),\ Q(x_i)] = r$. Examples of these laws abound in almost all the sciences e.g. laws of quantum mechanics, genetics, psychology, etc., but perhaps are most frequently encountered in games of chance. Our concern here is not to justify the use of these laws but to examine the special character of the explanations and predictions in which they occur.

Consider the following example of a statistical explanation of the occurrence of a particular event. The event to be explained is the behavior of a subject involved in the binary choice experiment. The object of the experiment is to determine whether the subjects involved in the series of tests behave in a fashion that is consistent with a particular law of behavior. The law in question is a statistical law stating that a very high percentage of all subjects will behave so as to maximize their expected utility. Assume that a specific subject is observed to behave in a manner

that is consistent with the maximization of his expected utility.
Accordingly the explanation for this event is given in the following way:
Since almost all subjects behave in this experiment so as to maximize
their expected utility, and since this particular subject does not differ
in any significant sense from any of the other subjects, we can conclude
that it was almost certain or very likely, that this subject would
behave so as to maximize his expected utility. It is apparent from this
example that we cannot deduce from our law that this subject will act so
as to maximize his expected utility. The best that we can do is assert
that it is very likely that he will behave in this fashion.

Under this formulation it appears that a statistical explanation is
really quite similar to what we have called a scientific explanation.
It appears that we can still deduce the occurrence of the particular event.
Upon closer examination, however, this apparent similarity disappears.

In a scientific explanation we employed a universal relation given
by 'all P's are Q's'. We then observed that if a given event had the
property P we were able to conclude that it also had the property Q.

But, in the case of a statistical explanation this is no longer
true. For example, let us alter our law so that it now becomes "almost
all P's are Q's"--that is, $p[P, Q] = r$ where r is the relative frequency,
say 0.95. We now observe the occurrence of an event, say X, and notice
that it has the property P. Clearly we can no longer conclude that X
will also have the property Q. On the contrary, since our statistical

law only refers to "almost all" of the events of type Y that have the property P, there are bound to be occurrences of the event X with the property P that do not have the property Q.

Even this situation would not cause us too much trouble if we could infer from our law the precise statistical probability with which events of type X having the property P also have the property Q. If this probability could be deduced from the statistical law then we would not have to restrict our conclusion to statements such as "it is very likely that this subject will behave in this fashion." On the contrary we could then deduce that "with a probability of q" this subject will behave so as to maximize his expected utility, where the term "probability" would refer to the normal frequency, or statistical, notion of probability. However, this conclusion cannot be made. The reason for this is that a statistical probability is not a property of an event or a statement but describes a relation that holds between two classes of events. In order to clarify this point let us examine once again our example of a statistical explanation. Our law is given by "almost all $P(x_i)$'s are $Q(x_i)$'s". Our observation is given the statement "event X has the property P". And we wish to determine the probability that we can attach to the statement "event X also has the property Q". Since the statement "event X also has the

property Q' is the conclusion that we are after it is clear that it stands

in some sort of relation to the two other sentences used in the explanans.

Thus, if we are to know the statistical probability to attach to this

conclusion we must know the statistical probability that characterizes

the relation between the conclusion and the explanans. That is to say,

somehow we need to be able to compute the probability that characterizes

the relation between the sentence "event X also has the property Q" and

the two other sentences 'event X has the property P' and 'almost

all P(x)'s are Q(x)'s. But a statistical probability characterizes

the relation between two classes of events. Therefore, it is not

possible to deduce the desired statistical probability. At best, the

desired probability can be represented by an inductive probability. A

notion of probability that is distinctly different from the frequency or

statistical notion.[6] Therefore, the only conclusion that can be drawn

is that the occurrence of the sentence 'event X also has the property Q'

is very likely when taken in relation to the two sentences 'event X has

the property P' and 'almost all P(x)'s are Q(x)'s.

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[6] For a more detailed discussion of the difference between inductive and
statistical probabilities see: R. Carnap, "Statistical and Inductive
Probability," in E. H. Madden (ed.), The Structure of Scientific Thought,
Boston, 1960, pp. 269-278; and for a more extensive analysis of inductive
logic see: R. Carnap, "On Inductive Logic", Philosophy of Science, Vol. 12,
1945.

Because we are unable to conclude any more than that the occurrence
of Q is very likely, the logical character of the explanation or the
prediction of Q(x) is quite distinct from that which we have previously
considered. Earlier we saw that if P was empirically confirmed, and our
explanation could be characterized by the expression $P \rightarrow Q$, then the
unsuccessful prediction of Q could be used to disconfirm the expression
$P \rightarrow Q$. But if the law is stated as $p[P, Q] = r$, then no matter what evidence
we have confirming P the unsuccessful prediction of Q cannot be used to
disconfirm the law. Thus, the inclusion of probabilistic laws into the
theoretical structure also precludes the possibility of employing the cri-
terion of prediction as the sole means of confirming or disconfirming
the derived relations.

2. Other Approaches to Empirical Validation

Since the successful prediction of the occurrence of an event can
be used to empirically confirm or disconfirm the expression $R \rightarrow S$ only
if the hypothesis R is also empirically confirmed, we shall now turn to
an examination of the methods employed by economists to establish the
empirical truth value of R. To facilitate this discussion we shall conduct
this analysis in terms of the theory of demand allowing the reader to
extrapolate the argument to the relevant portions of the remainder of
micro-economic theory.

In Chapter V, it will be remembered, we concluded that the derived

laws of the theories of utility and demand were not capable of being

directly refuted by empirical test because they lacked sufficient

empirical interpretation. Employing the logic of prediction it then

follows that neither the successful nor the unsuccessful prediction of an

event can be used as evidence for the empirical truth value of these

laws. If we cannot employ the technique of direct testing or that of prediction

to confirm these laws we must now examine other suggested methods for

extablishing their empirical truth value.

A   Independent Confirmation

One possibility is to see whether a set of tests can be devised

that will allow these laws to be subjected to a series of tests that are

independent from their normal use in the explanation and prediction of

economic events. If such a set of tests can be developed then not only

will these laws be refutable by empirical test, but they will also

confer empirical content on the explanations and predictions in which

they are employed. Further, and what is more important, a body of laws

will have been established that will assist in the determination of the

empirical validity of other hitherto untested laws.

For example, in Chapter V, Section I, we presented an illustration

of a scientific explanation. In that example three laws were explicitly

mentioned: A quantitative law relating the change in pressure of water

to its temperature and volume; a law stating the temperature at which

water freezes given normal atmospheric pressure; and a law that stated

how the pressure of a mass of water behaved when the volume was not
allowed to increase and the temperature was lowered sufficiently to
allow the water to freeze. Each of these laws can be subjected to a
series of empirical tests that not only can be conducted independently
from each other, but can also be performed independently from their
use in the explanation of our particular event. Thus, when they are
used together to establish the explanation of the cracking of the water
container their own empirical validity ensures that the explanation has
empirical meaning. Consequently, a prediction can be used to confirm or
disconfirm particular hypotheses.

To be able to verify micro-economic laws independently from their
use in explanations of economic events would imply that at least one
of the two following conditions would have to be fulfilled: (i) that
a series of tests could be established for the law of demand, or the law
of maximization of utility, that was independent of the particular
economic context in which it was used, (ii) that the law's parameter values
determined by the data from one historic[7] event could then be directly
applied to the explanation of another historic event.

The first condition implies that the empirical truth values of these
laws must depend on the extent to which they are confirmed by the direct
observation of human decision-making behavior. While this is not a
novel conclusion it implies that psychological and other behavioral

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[7] The term "historic" is used to denote an event occurring during a
particular time period and in a specified spatial location.

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evidence must be taken into consideration when formulating and testing
these laws. Consider, for example, our previous reference to the binary
choice experiment. In this experiment the choice situation is so
structured that it is possible to determine at all times when the subject
is behaving in a fashion that is consistent with the theory of utility
that is being tested. If we let P and Q be variables representing the
postulates of the theory and R a variable representing the derived law
of utility maximization we can represent the theory by the expression
$P \cdot Q \to R$. By repeating the experiment with a variety of subjects we can
discover whether these subjects do in fact always behave in a fashion
that is consistent with the behavior prescribed by R. That is to say,
we can ascertain, in this situation, whether R is empirically confirmed
or not. To be able to conclude that the expression $P \cdot Q \to R$ is also
empirically confirmed we would have to separately gather evidence that
supported the postulates P and Q. But, if we were testing the theory
of utility in a normal situation it would no longer be possible to
determine beforehand precisely what behavior patterns would be
consistent with R. Hence, we would have to be able to confirm P and Q
by separately observing the subject's decision-making behavior before any
evidence in support of R could be used to help confirm the relation
$P \cdot Q \to R$. In this case P and Q would have to represent postulates
that were empirically confirmable by reference to some set of
psychological or other behavioral evidence. In this way, the theory
would be provided with empirical content and the empirical validity of
$P \cdot Q \to R$ would be independent of a particular economic context.

If the second condition held it would mean that the data from one
historic event would be sufficient to determine the law's parameter values
which must now hold for a second historic event. In Chapter V we saw that
this condition could be met if the law was formulated in terms of an ideal
case. We noted that the law relating the free fall of bodies near the
earth's surface to their acceleration is provided with sufficient
interpretive rules so that the evidence from a particular test of this
law can be used to confirm or disconfirm the ideal hypothesis. We then
examined the derived laws of the theories of utility and demand to see
whether these laws could be treated in a similar manner. It was
discovered, however, that each of these laws contained at least one
unidentified exogenous variable. The presence of unidentified exogenous
variables, e.g. the wants and preferences of a consumer in the law of
demand, implies that the set of events over which the law is supposed
to hold cannot be completely defined or identified. Accordingly, there
are an insufficient number of interpretive rules to allow one to determine
whether the behavior of the consumer is consistent with the law or not.
Until a sufficient number of interpretive rules are supplied it is not possible
to employ the data gathered from one historic event to completely determine
the parameters of the system. If the theoretical system can not be
completely determined at one instant of time, then it is not possible to
assert that the parameter values determined from the data of this historic
event should hold true for a second historic event. Thus, as the laws of

the theories of utility, and demand as not ... either of these two conclu...
we must conclude that it is not yet possible to independently establish
the empirical validity of these laws.

B. Deduction from Empirically Valid premises

So far we have seen that we cannot confirm the laws of the theories
of utility and demand either directly or independently from their use
in the explanation of economic events. The only alternative that remains
is to examine whether these laws can be deduced from empirical premises.
If these premises are formulated in such a way that they can be empirically
confirmed, then the deduced laws will in turn become capable of refuta-
tion by empirical test, and the dilemma will be resolved. In the
theory of demand these premises are represented by the basic postulates
of the theory of utility. But we have already seen that it is not
possible—except in a few heroically simplified cases—to subject these
postulates to empirical tests. As in the case of the derived laws,
the theory does not contain a sufficient number of interpretive rules
to allow these ideal postulates to be directly compared with observable
behavior. However, if we are to be able to subject the theory of demand
to empirical tests these postulates must be interpreted so that they are
capable of being directly confirmed by empirical test.

In this respect it is worth noting that many economists do not agree
that it is necessary to subject these postulates (or assumptions as they
are sometimes called) to empirical tests. On the contrary, these

theorists argue that the postulates should be accepted as true without

subjecting them to any tests. Further, they assert that it is only the

laws that are deduced from these postulates that should be subjected to

a process of empirical confirmation.[8] But we have already demonstrated

that it is not possible to confirm these laws by direct tests. Consequently,

the adoption of this position deprives micro-economic theory of any possible

empirical content and of any interest to empirical science.

This is not to say that economics must be a part of empirical science.

On the contrary, it has frequently been held that economics should be and

in fact is an axiomatic discipline.[9] To accept this point of view

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[8] For examples of this methodological approach to economic theory consider
the following: "We do not need controlled experiments to establish
their [the premises] validity; they are so much the stuff of our
everyday experience that they have only to be stated to be
recognized as obvious." Linoel Robbins An Essay on the Nature and
Significance of Economic Science. London, 2nd. ed., 1935, p. 79. The
numerous statements of this position found in the papers of the "Marginalist
controversy" in the American Economic Review, op. cit. And more recently,
"Thus, the fundamental assumptions of economic theory are not subject to
a requirement of independent verification but instead to a requirement of
understandability in the sense in which men can understand the actions of
his fellow men." Fritz Machlup, "The problem of Verification in Economics,"
op. cit. p. 17.

[9] "What assigns economics its peculiar and unique position in the orbit of
pure knowledge and the practical utilization of that knowledge is the
fact that its particular theorems are not open to any verification or
falsification on the ground of experience." Ludwig Von Mises,
Human Action: A Treatise on Economics, Yale University Press, 1949, p. 33.

implies, as we have already seen, that (a) the body of micro-economic theory cannot be used to establish scientific explanations or predictions of economic events, (b) the theory would be devoid of empirical content and hence policy prescriptions could not be based on any tested empirical laws, and (c) this axiomatic discipline should be renamed, perhaps meta-economics, so that there would be no confusion between the aims and interests of meta-economists and those who were concerned with developing theories to explain empirical phenomena.

The point at issue in this essay though is not whether economists should or should not become meta-economists. On the contrary, we have assumed for the purposes of this essay that micro-economics ought to be a part of empirical science. Clearly, it is this presupposition that has led us through the foregoing analysis and up to the impasse we currently face.

Our goal is to employ the theory of demand to make testable predictions about consumer behavior. But our analysis has shown that it is not possible to do so. And, it is the disparity between the objective and the performance that creates the dilemma facing economists today.

If we can abandon the goal of predicting behavior we can avoid the dilemma. But to adopt this policy is to ensure that the theory of demand will always remain empirically vacuous. A more attractive alternative is to resist retreat and apply our energies to discovering a way of overcoming it. And it is toward this objective that the remainder of this essay is devoted.

CHAPTER VII

TOWARD A SET OF TESTABLE POSTULATES

If the analysis in the preceding chapters is correct the dilemma
facing micro-economic theory, and in particular the theory of consumer
demand, can be summarized as follows:

a) The derived laws of the theories of utility and demand
contain unidentified exogenous variable, customarily to be
found in the ceteris paribus clause. These laws can
neither be confirmed nor disconfirmed by empirical test.

b) The derived laws could be empirically confirmed if and only
if the basic postulates were empirically confirmed.

c) The basic postualtes do not contain a sufficient number of
interpretive rules to permit them to be empirically confirmed.

d) To be able to establish scientific explanations and predictions
of economic events the laws of the theories of utility and
demand must be formulated so that they can be subjected to a
process of refutation by empirical test.

To state the problem, however, is not to solve it; even though an
explicit statement of a problem is a necessary first step towards its
solution. But it is frequently the case that the formulation of a
problem itself provides clues as to the possible direction in which a
solution may be found. And our dilemma does not appear to be an exception
to this rule.

Our analysis has revealed that one way of turning theoretical
structures into empirically testable theories is to develop a set of
basic postulates from which fully identified laws can be deduced. Hence,
if we are to convert the theory of demand into an empirically testable theory,
one approach is to construct some testable postulates from which either
the current or a revised theory of demand can be directly inferred.

If a new set of postualtes are to be constructed that can be
corroborated[1] by empirical tests this implies, as we have seen, that they
must be formulated in such a way that they can be subjected to tests that
are independent of a particular economic context. Consequently, if we are
to be able to confirm these postualtes independently of a specific
economic context, then it would appear that they must be tested by
direct reference to a fairly wide range of observable behavior. This
train of reasoning suggests that the construction of these testable
postulates would require a fairly close inspection of individual
decision-making behavior. It would also appear to suggest that these
postulates would then form the basis for a theory of individual decision-
making behavior, which in turn would act as the empirical basis for the
theories of utility and demand.

We are suggesting, therefore, that a possible solution to our dilemma
can be found by first constructing a theory of individual consumer behavior.

1/ In the remainder of this essay the term "corroborate" will be used as
a synonym for the term "confirm".

This theory must be a general theory of behavior, and hence must be based and tested upon a wide variety of decision-making behavior. The second step is to employ the theory of individual consumer behavior as the empirical basis for the theories of utility and demand. If this procedure is to succeed the current theories of utility and demand will have to be revised to accommodate such new concepts and relations as are introduced by the underlying theory of decision-making behavior. In effect, we are suggesting that a solution to our dilemma lies in "reducing" the theories of utility and demand to a testable theory of individual consumer behavior.

So far in this essay we have not explored the practical or the theoretical possibility of formulating such a theory of decision-making behavior. But before we turn our attention to this problem we shall first examine the process of "reduction" alluded to above. Our object is to examine the basic requirements that a theory of decision-making must meet if it is to form an empirical basis for the current theories of utility and demand--that is, if the theories of utility and demand are to be "reduced to" a theory of individual consumer behavior.

1. On the Theory of Reduction[2]

The term "reduction" is usually employed in science to denote the process whereby one branch of science, say chemistry, is reduced to

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[2] This section is principally indebted to E. Nagel's paper, "The Meaning of Reduction in the Natural Sciences," Science and Civilization, R. C. Stauffer (ed), University of Wisconsin Press, 1949, pp. 99-135.

another branch of science, say physics. What is meant by the term can
briefly be characterized as follows: the reduction of chemistry to physics
is said to have taken place if it is possible to formulate a theory
involving only the terms of physics that is sufficient to explain all
the phenomena that are explained by chemical theories. That such a
reduction of one branch of science to another is considered to be desirable
is evinced by the economy introduced into the theoretical vocabulary. If
all phenomena in chemistry are explainable in terms of physical theories
and observations recorded in physical terms, then all special terms previously
contained in chemical theories may be put to one side and replaced by the
appropriate physical terms. Needless to say, this economy is only
achieved if the resulting physical theory has not been unduly increased
in complexity and does not require a large number of special assumptions
to allow the reduction process to take place.

For our purposes, however, we wish to consider another, and less
frequently noted, application of the reduction process. The process we
wish to consider is one in which a body of theory within a particular
branch of science in replaced by a new theory that not only explains all
the phenomena covered by the first theory but also a further set not
covered by the previous theory at all. This is the process of reduction
within a given branch of science. It can be more formally characterized
as follows: Let T_1 represent the new and more comprehensive theory, and
let T_2 represent the original and less comprehensive theory. Then the reduction

of T_2 to T_1 is said to have occurred if and only if:

> "(1) The vocabulary of T_1 contains terms not in the vocabulary of T_2.
>
> (2) Any observational data explainable by T_2 are explainable by T_1.
>
> (3) T_1 is at least as well systematized as T_2."[3]

It is important to note that this process of reduction characterizes, within a particular branch of science, the process of developing new and more comprehensive theories. Also it should be noted that the development of the theory T_1 frequently entails a process whereby T_1 is based upon a set of data and postulates that are at a more microscopic level than those employed by the previous body of theory, T_2. In other words the process of reducing T_2 to T_1 and, consequently the process of developing the new and more comprehensive theory, T_1, frequently depends upon the existence of a body of data that is at a more microscopic level than that employed by T_2. For without the incentive provided by a more detailed level of data it is unlikely that T_1 would even by constructed. Hence, the reduction of T_2 to T_1 usually takes place after a set of relevant data have been discovered which are at a more microscopic level than the data explained by T_2.

For example, consider the theoretical developments in physics that may be characterized by the meanings that can be given to the concept of temperature. First consider what is usually meant by the concept of

3/ P. Oppenheim and H. Putnam, "Unity of Science," Minnesota Studies in the Philosophy of Science. University of Minnesota, Vol. II, 1958, p. 5. Note that the term "systematized" is introduced and its meaning in relation to theories is explained in: J. G. Kemeny and P. Oppenheim, "Systematic Power," Philosophy of Science. Vol. 22, 1955, pp. 27-33.

temperature when a subject is presented with a mercury thermometer and
is asked to determine the temperature of a particular container of water.
After immersing the lower part of the thermometer in the water and
allowing the mercury column to come to rest, the subject could be expected
to state that the temperature of the water was, say, 20°C. If this subject
was then asked to explain why it is that he can measure the temperature of
water with the mercury thermometer, he might invoke the physical theory
relating the volume expansion of mercury in a closed tube to the
temperature of a body placed in contact with the mercury tube. If the
antecedent conditions and the properties of the mercury column were
properly specified he would have established an explanation of what he
meant by the fact that the temperature of the water was 20°C. But, if
we asked our subject to measure the temperature of substances that were
either extremely hot or cold he would find that the mercury thermometer
would no longer be sufficient to establish explanations. The mercury
would either be vaporized or in a solid state. One alternative would be
to construct explanations for these extreme temperatures in terms of
other measuring instruments and the theories they invoke, e.g. thermocuples,
pyrometers, and bolometers. But another alternative would be to turn to
a more comprehensive theory of physics--namely, the kinetic theory of
matter--where the temperature of a substance is expressed as the mean
kinetic energy of the molecules of which the substance consists. In
either event the theory that is invoked takes as its basic data
phenomena that are microscopic when compared to the data employed in the

theory invoked earlier to explain the behavior of the mercury column. What in effect has happened is that the laws of thermodynamics have been reduced to the laws of the kinetic theory of matter. What were once the basic postulates of the theory of thermodynamics are now the derived laws of the kinetic theory of matter.

Before we proceed to examine whether the basic postulates of the theories of utility and demand can be derived from some empirically testable micro-theory, we must first consider what is formally required before we can state that one theory has been successfully reduced to another.

The first condition follows directly from what we have stated is the objective of the reduction process--that is, to show that the laws and postulates of T_2 are directly deducible from the laws and postulates of the new theory T_1. If the laws or postulates of T_2 contain terms and expressions that do not appear in T_1 then it is clear that we cannot directly deduce T_2 from T_1. In this case various assumptions or further postulates must be introduced to link the terms in the derived laws of T_1 to the terms and expressions of T_2. For example, in our discussion of the various ways in which the concept of temperature could be explained we pointed out that one explanation could be given by using the laws of thermodynamics and the properties of the mercury column. While another could be given by employing the kinetic theory of matter. The concept of temperature occurs directly in the laws of thermodynamics. But it does not occur at all in the statement of the kinetic theory of matter.

Thus, if we are to claim that the theory of thermodynamics has been
reduced to the kinetic theory of matter some way must be found for
linking the concepts of the kinetic theory to the concepts in the theory
of thermodynamics. In actual practice that obstacle is overcome by the
introduction of the assumption that the thermodynamic concept of temperature
is directly proportional to the kinetic theoretic concept of the mean
kinetic energy of the molecules. With the addition of this assumption
the laws of thermodynamics can now be inferred from the kinetic theory of
matter. From this discussion we can see that a necessary condition for
the reduction of T_2 to T_1 is that suitable relations be constructed so that
the terms and expressions contained in T_2 are derivable from the basic
postulates and concepts of T_1.

Another condition that must be met, if we are to consider T_2 to have
been successfully reduced to T_1, is that the basic postulates or
principal hypotheses of T_1 must be empirically testable as well as being
reasonably well confirmed by the available evidence. The purpose of this
condition is to ensure that we do not construct essentially trivial
reduction theories. It would not be an important scientific accomplishment
merely to construct a set of postulates from which T_2 could be deduced,
if we were then unable to test or empirically confirm them. Therefore,
before we can accept a theory, say T_1, as a possible basis for the
reduction of T_2 we must be sure that the postulates or principal
hypotheses of T_1 are both testable and reasonably well confirmed.

The condition of being "reasonably well confirmed" is admittedly vague. And, as has been pointed out earlier, the problems involved in determining the degree of confirmation go beyond the scope of our analysis. However, it is clear that a striking confirmation of these hypotheses takes place if hitherto unknown relations between observable phenomena are both deducible from the theory and supported by the available evidence. Further confirmation is supplied if the deduced relations of T_1 are actually in better agreement with the data explained by T_2, than the original relations contained in T_2. While these conditions do not define the degree to which a theory is confirmed they do provide important evidence that the empirical support for T_1 is greater than that which had been found for T_2.

From this discussion it is evident that the reduction of one body of theory to another cannot be said to have taken place unless the principal hypotheses of the new theory are tested and confirmed independently of the original theory. Further when discussing the reduction of T_2 to T_1 the state in which these two theories are presented is also very important. That is to say, it must be demonstrated that the relations and deduced laws of T_2 are derivable from the new theory T_1. Also it should be noted that even though it is demonstrated that T_2 is reducible to T_1 this does not automatically invalidate the laws, concepts and postulates of T_2. On the contrary, the reduction of T_2 to T_1 may in effect strengthen the empirical confirmation of T_2, even though some of the laws of T_2 may appear to be only approximations to the more highly confirmed and precise laws of T_1.

2. On Reduction and a Theory of Human Decision-Making

Having outlined the theory of, and the conditions under which the reduction of one theory to another is said to have taken place, we shall now return to the task of determining whether we can construct a theory that will serve as a basis for a micro-reduction of the theories of utility and demand. As noted earlier, it appears that if we are to be able to successfully reduce the theories of utility and demand, then the reducing theory will have to be a theory of individual decision-making behavior. While this is not a novel conclusion[4] it implies that we should begin our search for the postulates of our reduction theory among the recent researches in behavioral theories[5] and the simulation

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4/ For example, Emile Grunberg, op. cit. p. 347, pointed out both the desirability and the possibility of reducing economic theory to psychological or behavioral terms.

5/ The most notable of the early researches in behavioral theories can be found in: R. M. Cyert and J. G. March, "Organizational Structure and Pricing Behavior in an Oligopolistic Market," American Economic Review, Vol. 45, 1955, pp. 129-139, and R. M. Cyert, E. A. Feigenbaum and J. G. March, "Models in a Behavioral Theory of the Firm," Behavioral Science, Vol. 4, April 1959, pp. 81-95; also for a detailed presentation of a new theory of the firm see: R. M. Cyert and J. G. March, The Behavioral Theory of the Firm, Prentice-Hall, Englewood Cliffs, 1963.

of individual decision-making behavior.[6] In spite of the fact these

researches are not all concerned with explaining the same economic events,

they all employ a set of basic hypotheses that assert certain regularities

in the decision-making process of economic actors. But before it is worth

inspecting these theories to see if they can serve as the basis for our

reduction theory we need to examine the theory of individual decision-

making behavior from which these theories have evolved.

A A Theory of Human Problem Solving

The theory of human problem solving that we shall consider was

developed by Newell, Shaw, and Simon[7] to explain and predict the

performance of a human problem solver handling various specified tasks.

The object of the theory is to explain the process of human problem

solving by identifying the types of decision processes that humans employ

while solving a variety of problems. Although questions about decision-

making could be answered at various levels and in varying amounts of

detail, this theory explains problem-solving behavior in terms of a set

of basic information processes. These processes are in part defined by

the theory's three basic postulates which state that there exists for each

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6/ For a survey of recent research in the simulation of decision-making
behavior see the papers presented by G. H. Orcutt, M. Shubik, and
G. P. E. Clarkson and H. A. Simon in "Simulation: A Symposium,"
American Economic Review, Vol. 50, Dec. 1960, pp 894-932. For a more
extensive analysis of the problems of simulating human decision-making
behavior see: A. Newell and H. A. Simon "The Simulation of Human
Thought," Current Trends in Psychological Theory, University of
Pittsburgh Press, 1961, pp. 152-179.

problem solver:

"(1)   A control system consisting of a number of memories which

contain symbolized information and are interconnected by

various ordering relations...

(2)   A number of primitive information processes, which operate on

the information in the memories...

(3)   A perfectly definite set of rules for combining these

processes into whole programs of processing..."[8]

To further clarify what is meant by these postulates consider the

following example of an application of these postulates that is

contained in a recently proposed theory of trust investment behavior.[9]

This theory of investment behavior was developed to explain and predict

the portfolio selection process of a particular trust investor. The

basic postulates of the theory state that for the trust investor there

exists:

"(1)   A memory which contains lists of industries each of which has

a list of companies associated to it. The memory also contains

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7/   A. Newell, J. C. Shaw, and H. A. Simon. "Elements of a Theory of
Human Problem Solving." *Psychological Review*, Vol. 65, No. 3, 1958,
pp. 151-166.

8/   *Ibid.*, p. 151.

9/   G. P. E. Clarkson. *Portfolio Selection: A Simulation of Trust
Investment*, Prentice-Hall, Englewood Cliffs, 1962.

information associated with the general economy, industries
and individual companies. [Investors categorize companies
by industry. Not all investors may associate identical
companies with a given industry, but the process of
classification by indsutry remains invariant as the primary
basis for listing companies in the memory. The information
associated with each company also varies among investors, but
each may be represented as having a list of attributes with
their values stored in memory, e.g. growth rate, dividend rate,
price earnings ratio, expected earnings, expected yield, etc.]

(2) Search and Selection procedures which perform the task of
searching the lists of information stored in memory, selecting
those items that have the required attributes, regrouping the
selected pieces of information into new lists, and performing
algebraic operations when necessary. These procedures function
in a manner similar to that of the traditional clerk who
prepares lists of stocks suitable for current investment by
scanning a master list.

(3) A set of rules or criteria which guide the decision-making
process by stipulating when and how each process is to be used.
The set of rules constitutes the structure of the decision
process for an individual investor. It might be compared to
the heuristics of the traditional "expert," but as previously

noted, there is an important difference--namely, the set of
rules must be defined unambiguously."[10]

As can be seen from this example, it is a basic assumption of the
theory of human problem solving that decision processes can be isolated
as well as identified. And further that they can be represented by a
series of straight forward mechanical processes. This is not to say that
decision processes are simple or easy to represent. But rather that they
can be broken down into their elemental parts, e.g. the memory, the
search and selection procedures, and the rules for combining these
processes, which in turn consist of collections of simple mechanisms.
When these operations are recorded in a set of statements that describe
the decision behavior of the individual under investigation, this set of
rules becomes the theory of the individual's decision-making process. That
this set of rules can be considered to be a theory is evidenced by the
requirement that it must be possible to deduce uniquivocally the externally
observable behavior that will be generated from them. In order to ensure
that this condition is met, the set of postulates and statements are
translated into a computer language and tested on a digital computer.
Thus, as in the more familiar case of our scientific theories, the
logical consequences are derived by performing the particular operations

10/ Ibid., p. 27.

according to the specified rules. In an actual test the behavior generated
by the theory is compared with the observed decision behavior of the
individual under consideration. When the rules and postulates for
processing the information yield results that are consistent with those
obtained from the human subject, the theory is said to be sufficient to
account for the observed behavior. Hence, the theory of human problem
solving establishes a theory of decision behavior by providing a basic
set of postulates and hypotheses that when appropriately interpreted are
asserted to be sufficient to generate the observed behavior.

B On Testing the Hypothesized Relations

From our earlier discussion it was clear that if we were to employ
a set of postulates as the basis of our reduction theory then these postulates
must be independently confirmable by empirical test. In the event that
we are to be able to reduce the theories of utility and demand to some
new theory of decision-making behavior then these postulates must also
be well confirmed. However, we are primarily concerned with discovering
whether it is possible to carry out this reduction process. Hence, it
will be sufficient for our purposes if we can show that the basic postulates
of human problem solving are confirmable independently from a particular
economic context.

In order to facilitate this analysis we shall make use of the following
example of an explanation of an economic event that is proposed by the
theory of trust investment mentioned above.

The event to be explained consists of the selection of a specific
portfolio of securities by a particular trust investor for a specified
trust account. To establish an explanation for this event the theory
requires that the initial and boundary conditions $(O_1 \, T_1, \, O_2 \, T_2, \, ..., \, O_n \, T_n)$
include: Data on the historical, current and expected values of
relevant financial attributes e.g. price, yield, earnings per share, etc.
for a specified list of securities. Data on the historical, current and
expected values of specified industrial and economic indices, And data
on the particular trust account in question. The basic postulates of
the theory, as noted above, specify that the trust investor can be
represented as having: (i) a memory which contains the data given above
listed in a particular form, (ii) a set of procedures that allow the
data in the memory to be searched, manipulated, and desired pieces selected
for further processing, and (iii) a set of decision rules that determine
the decision-making process by stipulating when and where each decision
process is to be applied. These postulates are concerned with the trust
investor's decision procedures and they define both the structure and the
order in which the decision processes are carried out.[11/] When they are
employed in conjunction with the initial and boundary conditions

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11/ It should be noted that these postulates and decision rules are
     stated in sufficient detail to permit their programming and testing
     on a digital computer.

$(\underline{O}_1 \ \underline{T}_1' \ \ \underline{O}_2 \ \underline{T}_2' \cdots \underline{O}_n \ \underline{T}_n')$ they allow the decision process to be carried through and a particular portfolio of securities to be selected. Consequently, the explanation of the selection of a particular portfolio is established by applying the decision procedures specified by the theory to the data of the security market and of the particular trust account in question.

If we were interested in ascertaining whether this theory of trust investment could be suitably amended to serve as the basis for a micro-reduction of a theory of investment we should first want to determine whether this explanation was a scientific explanation or not. To decide this question we need to examine the postulates to see either if they are refutable by empirical test within their economic context, or if they can be corroborated independently from their use in the explanation of portfolio selections. If either of these conditions hold, it will be remembered, we are able to conclude that this theory has established a scientific explanation for this economic event. If both of these conditions hold this would be strong evidence in favor of the hypothesis that the theory of trust investment could be used as the basis for reducing the economic theory of investment to a testable theory of investment decision-making behavior. Clearly we are primarily interested in discovering whether these postulates can be tested independently of their economic context. But, if it can be shown that they are also capable of being refuted within their economic context, then this evidence would support the hypothesis that the basic postulates of the

theory of human problem solving could also be used as the basis for a micro-reduction of the theory of demand. Therefore, we shall first examine whether it is possible to directly corroborate the postulates of the theory of trust investment.

The theory of trust investment was developed to explain and predict the portfolio selections of a particular trust investor. It was constructed by incorporating into the theory such decision mechanisms as were (observed and inferred) from the trust investor's behavior. To test the theory's ability to reproduce the decision behavior the theory was given the data of the security markets and of some specified trust accounts for a particular period of time. It was then required to generate portfolios for these trust accounts. But the specific portfolio selections constitute only the final result of the trust officer's decision process. Hence, the theory was also subjected to a set of tests that compared the behavior generated by its decision mechanisms with the recorded behavior of the trust investor.

In the actual testing program the theory was submitted to a series of these tests. In fact both the theory's portfolio selections and its decision processes were compared with those of the trust investor's on four separate occasions over a period of nine months.[12] Despite the

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[12] For a detailed presentation of the empirical tests and the results
       obtained from this testing procedure see: Ibid., Chapters 5 and 6.

fact that it is of some interest to be able to predict the actual portfolio selections of a particular trust investor, there are presumably a variety of theories that will permit this result to be accomplished. What is of greater importance, is the fact that the theory's generated decision behavior compared favorably with the observed decision behavior of the trust investor--that is to say, it appeared, even on close inspection, that the theory was employing many of the same decision procedures and was arriving at the same results for substantially the same reasons as the particular trust investor under investigation.[13] By comparing the behavior generated by each of the theory's important mechanisms directly with the observed behavior of the trust investor it was possible to submit the theory's decision processes to a direct process of refutation by empirical test. Manifestly, this testing procedure is capable of being repeated. Also the theory's decision processes are capable of being compared with observed behavior to whatever level of detail is desired. Hence, while the theory of trust investment may or may not have been adequately confirmed, it is apparent that it is quite possible to corroborate both its postulates and its generated hypotheses.

Having concluded that the theory's postulates are testable within their economic context, we shall now examine whether they can also be empirically confirmed independently from their use in the explanation

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13/ For the results of the direct tests of the theory's decision
      mechanisms see: Ibid., Chapter 7.

of economic events. Theories of individual decision-making behavior
are concerned with explaining various aspects of human problem solving
behavior. Also their postulates make definite assertions about the
structure and ordering of certain decision processes. Therefore, it is
both in principle and in practice possible to study human decision-
making behavior independently of a particular economic context. For
example, the decision-making behavior of individuals engaged in the
solution of problems in geometry, logic, or chess[14] to mention but a
few examples, can be used as the basis from which to test the empirical
validity of many of the hypothesized decision processes. This is not to
say that all the hypotheses of a theory, say the theory of trust investment
can be tested in this manner. Obviously, some of them, e.g. the order in
which companies are listed in the memory, the order in which the testing
and selecting of securities is performed, etc., will be peculiar to the
particular economic context. What we are asserting is that a certain
is that a certain number of invariances exist in the decision processes
of different problem solvers. And that it is possible to determine their
empirical truth value. For example, the theory of human problem solving

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14/ It is worth noting that the decision processes employed in the
theory of trust investment were principally derived from researches in
human problem solving that used the problems of geometry, logic and chess
as their sources of empirical evidence. See for example: A. Newell, J. C.
Shaw, and H. A. Simon, "Empirical Explorations of the Logic TheoryMachine,"
Proceedings of the Western Joint Computer Conference, Feb., 1957, pp. 218-230,
and "Chess-Playing Programs and the Problem of Complexity," IBM
Journal of Research and Development, Oct., 1958, pp. 320-335; and H. L.
Gelernter, J. R. Hansen, and D. W. Loveland, "Empirical Explorations of
the Geometry Theorem Machine," Proceedings of the Western Joint Computer
Conference, 1960, pp. 143-159.

contains three main postulates which assert the existence in a human
decision-maker of a memory, some primitive information processes, and
a hierarchy of decision rules. The theory of trust investment turns
these postulates into testable hypotheses by specifying in detail the content
of the trust officer's memory and information processes as well as the
content and order of his decision rules. If it was not possible to specify
how to characterize these processes, then it would not be possible to
directly adopt these postulates into a theory of investment behavior. In
effect, we are arguing that unless invariances, like the structure of the
contents in memory, exist between problem solvers, then it is not possible
to construct a theory of human problem solving in this manner.

It should be noted, however, that the hypotheses of several theories
of decision-making behavior [15] are directly derived from the basic postulates
of the theory of human problem solving. Consequently, it appears that
the empirical truth value of these postulates can be determined by a series
of tests in a variety of empirical contexts. Also it should be noted that

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15/ For examples of these theories see: E. A. Feigenbaum, "The Simulation
of Verbal Learning Behavior," Proceedings of the Western Joint Computer
Conference. Vol. 19, May 1961, pp. 121-132; J. Feldman, "Simulation of
Behavior in the Binary Choice Experiment," Proceedings of the Western
Joint Computer Conference, Vol. 19, May 1961, pp. 133-144. (Both of
these papers are reprinted in E. A. Feigenbaum and J. Feldman (eds).
Computers and Thought, McGraw-Hill, 1963.); and A. Newell, J. C. Shaw
and H. A. Simon, "A General Problem Solving Program for a Computer,"
Computers and Automation, Vol. 8, July 1960, pp. 10-17.

we are not asserting that all the hypotheses employed in these theories have been subjected to such a series of tests, but rather that it is in principle possible to do so and our references to the literature contain examples where such a program is already being carried out.

For the purposes of our analysis, therefore, it is sufficient to demonstrate that it is possible to carry out such a testing procedure,[16] Because, if we assume for the moment that the appropriate empirical tests are performed, and that some of these postulates are not disconfirmed, then these postulates will have become independently tested empirical hypotheses and the solution to our dilemma would be in sight.

At this point it might be argued that even if we accept the proposition that certain hypothesized decision processes can be empirically confirmed, in what manner does this alter the essentially ad hoc character of these decision-making theories? After all, decision-making theories no less than current micro-economic theories are concerned with explaining and predicting historic events, and are constructed and amended to fit the data of particular events.

16/ The reader will note that we have repeatedly stated that it is not necessary for the purposes of this essay to examine the problems involved in ascertaining the degree of confidence in which a given hypothesis or theory is held.

To argue in this fashion, however is to disregard one very important point. By demonstrating that specific postulates about human problem solving behavior can be empirically confirmed we have turned the original postulates about human behavior into empirical hypotheses. Once we have a set of confirmed hypotheses all hypotheses that can be deduced from them become in turn capable of being, at least indirectly, confirmed or disconfirmed by empirical test. Hence, while a particular theory, say the theory of trust investment, may be employed in the explanation of a particular economic event, the independent testability of its basic hypotheses ensures that a scientific explanation has been established.

As we have already seen, what is true for a scientific explanation is also true for a scientific prediction. In other words, once some of the postulates have been established as empirical hypotheses, the prediction of the occurrence of an event can now be used as a basis from which to test the remainder of the hypotheses in the theory. For example, the trust investment theory was tested by requiring it to predict, under varying market conditions, the trust officer's portfolio selections. The predicted portfolios can be used to determine whether the decision mechanisms employed in the theory are sufficient to permit the changing economic conditions to be reflected in the securities that are selected. If the predicted portfolios compare favorably with the trust officer's at one period of time but not at another, then it would follow that the decision

processes were not sufficient to allow the theory to adapt its selections

to the prevailing market conditions.[17/] Therefore, to the extent that

empirical laws of decision-making behavior can be established we can then

develop a body of decision-making theory that will have the same explanatory

and predictive power as is enjoyed by other scientific theoires.

Conclusions

At the beginning of this chapter we arrived at the conclusion that if

we were able to resolve the dilemma facing the theories of utility and

demand, we would first have to be able to construct a testable theory of

individual decision-making behavior. We then demonstrated that it is

possible to construct such a theory. And further that a certain amount

of research in this direction has already been completed. As a result,

we are now faced with the problem of trying to show how the theories of

utility and demand are to be reduced to a theory of decision-making

behavior. But the required reduction theory just does not exist. Hence,

our task will be to explore the manner in which such a theory might be

developed, as well as the structure that it might be expected to have.

The object of this exercise is to provide the interpretive links between

a theory of decision-making behavior and the theory of demand. And it is

toward this goal that the next chapter is directed.

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17/ The evidence on the theory's ability to adapt to changing market
     conditions is presented in ibid, ch. 6.

CHAPTER VIII

T̲O̲W̲A̲R̲D̲ A̲ T̲E̲S̲T̲A̲B̲L̲E̲ T̲H̲E̲O̲R̲Y̲ O̲F̲ D̲E̲M̲A̲N̲D̲

In the previous chapter we have attempted to demonstrate that it is possible to develop a set of empirical hypotheses that can serve as the basis for a testable theory of individual decision-making behavior. Hence, if we are to reduce the theories of utility and demand to a theory of decision-making behavior, then it is clear that the reducing theory can be constructed so that it meets the first half of the second main condition. This condition requires the basic postulates or hypotheses of a reduction theory to be empirically testable. It is considerably less clear, without the theory being constructed and tested, that the second half of this criterion would be met--that is, that these hypotheses are also well confirmed. But this is a matter for empirical investigation. And it will be sufficient for our purposes to be concerned only with whether they can be considered to be empirically testable. Further, if the basis for the reduction process is to be a theory of human decision-making, then it would appear that statements would be deducible from this theory that would assert testable relations between observational phenomena that hitherto were not known. Since the basic theory would be empirically testable, and since researches into the simulation of human decision-making behavior have just begun, there appears to be a certain amount of prima facie evidence in favor of this conclusion. If this evidence can be accepted, for the time being, then it would appear that the reducing theory also meets the third

condition that is imposed to adjudge successful theoretical reductions.

Given that a suitably constructed theory of decision-making behavior meets the last two conditions we must now examine whether it can pass the first and most important cirterion--namely, whether the laws and postulates of the theories of utility and demand are directly deducible from the laws and postulates of the reducing theory. While the answer to this question is partly empirical--that is, do we have a theory that meets this test--it is the theoretical considerations that we shall be concerned with here. If the conditions for theoretically satisfying this criterion can be stated, and if it can be shown that a suitably constructed theory of decision-making behavior can meet these conditions, then our task will have been completed.

To build and test such a theory is a task for empirical research. But to examine the conditions such a theory must meet, and to point to the various components that such a theory might have, is a task for theoretical and speculative analysis. And it is toward both of these latter objectives that this chapter is directed.

1. Toward a Theory of Consumer Behavior

Before we can determine whether the theory demand can be reduced to a testable theory of decision-making behavior, we must have at least a general idea of the sorts of problems we are going to encounter. But in order to identify the types of problems this reduction process would entail we must first have a fairly clear idea of the kinds of behavior

the theory of decision-making is going to explain, and the types of
empirical statements that will be deducible from it. Thus, in order to
begin to ascertain whether the theories of utility and demand are reducible
to a theory of decision-making behavior, we must first construct, at least
in general form, the theory that is to effect the reduction process.

To construct a theory, however, we need to have some knowledge about
the events that the theory is supposed to explain. Do we wish to construct
a theory that is designed to explain the behavior of particular individuals?
Or is it the statistically average behavior of certain groups of consumers
that we wish to be able to predict and explain? Since we have based our
approach to the dilemma on the possible solution offered by a testable theory
of human problem solving, it would appear sensible to begin by developing a
theory that closely parallels these empirical investigations. Consequently,
we shall restrict our attention to the explanation of individual decision-
making behavior.

In the event a testable theory of individual behavior is constructed
that is sufficient to reduce the theories of utility and demand, we can
then turn our attention to the problems of aggregation, and the task of
constructing a more general theory of consumer behavior. But, we wish to
be able to make use of such evidence as exists on the behavior of individual
problem solvers. Thus we shall only consider the problem of developing a
theory of decision-making behavior for an individual consumer. However,
this need not appear to be as restrictive as it may sound. It should not be

forgotten that the theories of utility and demand were also originally constructed to explain the behavior of individual consumers.

From our earlier examination of these micro-economic theories we saw that they could be interpreted as "ideal" theories. That is to say, the theory of demand can be presented as a theory of "ideal" consumer behavior if a set of interpretive rules are provided so that the theory can be tested against the data of any particular case. It has also been noted that "ideal" theories or models are frequently employed in empirical science. Consequently, there appears to be a considerable amount of evidence in favor of approaching the problem in this manner. If we take the events to be explained as the decision-making behavior of individual consumers, then our task can be taken to be the construction of an "ideal" theory of consumer decision-making behavior which can be empirically interpreted to explain the behavior of a particular consumer.

The next question we must consider is the problem of where to begin. It is clear from our previous discussion that we are going to make use of the basic postulates of the theory of human problem solving. But these postulates are concerned with such things as the structure of memory and basic information processes. Thus, we must first have some idea of the particular way in which we wish to employ them before we will be able to specify their content in any detail. In order to be able to decide on the specific content these postulates should have, we should first examine some of the principal empirical statements that we shall want to be able

to deduce once the theory has been built.

The first set of expressions is a decision process that allows the consumer to allocate his total income among the various categories, or groups, of available commodities, such as housing, food, clothes, entertainment, etc. The assumption would be that the decision to allocate funds between various categories of commodities, while not necessarily being made at one instant of time, is nevertheless a conscious decision process the consumer engages in over a period of time. If we also assume, for the moment, that our consumer belongs to a particular income group, then it is also quite reasonable to postulate that as long as his income keeps pace with his social and economic peers his allocative decision procedure will not vary a great deal from one period of time to the next. Now clearly these are postulates that are both empirically testable and for which a certain amount of evidence already exists.[1] We are postulating that: (a) each individual consciously decides over a period of time what proportion of his income to spend on each category of commodities, (b) this decision procedure will remain constant over time, as long as his income does not vary significantly in either direction and (c) the proportions

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[1] Much of the evidence from recent economic research is reviewed in R. Ferber, op. cit. For a particular example of how an allocative procedure is introduced into current utility analysis see: I. F. Pearce, "A Method of Consumer Demand Analysis Illustrated," Economica, Vol. 28, Nov., 1961, pp. 371-394.

of his total income a consumer allocates to each category will be reflected

to a close approximation by the proportions allocated to these categories

by those consumers that are in the same social and economic class. This

is not to say we are postulating that each consumer must allocate the

same proportion of his total annual income to each category of commodities.

But rather, that we can postulate the existence of such a decision process.

And depending on whether we wish to explain the behavior of a particular

group or an individual consumer, we can adjust the relevant parameter

values to be consistent with the observed empirical evidence. For example,

it is clearly possible to observe the behavior of a particular consumer

and note that of his total annual income he allocates 26 per cent to rent

or other housing costs, 32 per cent to food, 24 per cent to expenditures

on clothing, furniture, and other household items, and the remaining 18

per cent to the expenses of travelling and recreational pursuits. It is

also possible to observe in a similar manner the allocative procedures

of a particular group of consumers who live in a specified geographical

region. Hence, if we wish to be able to explain this allocative process

we must construct a decision process in which it is possible to adjust

the relevant parameters, so that we may take into account the proportions

of more than one individual's allocative procedure.[2]

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[2] It should be noted that the notion of such an allocative decision
process is not a novel idea and that Strotz has developed a theoretical
formulation of it in current utility analysis; see R. H. Strotz, "The
Empirical Implications of a Utility Tree" Econometrica, Vol. 25, 1957,
pp. 269-280. See also I. F. Pearce, "An Exact Method of Consumer Demand
Analysis," Econometrica, Vol. 29, Oct. 1961.

If we are able to represent the allocation of the consumer's income between the various categories of commodities we must then examine the decision-procedures that govern the spending of the available funds within each category. In this case we shall need to construct decision procedures that govern the expenditure of the funds that have already been allocated to housing, food, clothing, etc. If we require our theory to be able to specify each one of these decision processes it would appear that the theory would have to be somewhat large and complex. However, if there are some similarities between the decision processes required to explain, say, the consumer's decision behavior in the category of food and his decision procedures in some of the other categories, then the task of constructing this theory may not be as formidable as one might previously have expected.

For example, the theory of trust investment is concerned with explaining and predicting the investment behavior of the trust investor while he is selecting a portfolio of common stocks. At the present time the theory does not consider the problem of allocating funds between bonds, preferred stocks and common stocks or the decision procedures that are required if funds are allocated to these categories. However, from the evidence presented in this study[3] it would appear that if these decision procedures had been taken into account they would have been constructed out of the decision processes already included in the theory.

3/ G.P.E. Clarkson, op. cit.

For a further example of the similarities that appear to exist among the
decision processes employed by a human to solve quite different problems
consider the principal decision processes that are incorporated in the
theory called the General Problem Solver.[4] The General Problem Solver
is a theory that represents some of the reasoning processes employed by
humans when confronted with the task of solving various types of problems.
This theory is principally concerned with the processes of reasoning.
And its decision processes contain no references to the subject matter of
any particular problem. Hence, if the theory is to be tested by using
it to prove some theorems in Eucledian geometry the axioms and rules of
inference have to be provided before the theory can be employed. That is
to say, if the theory is to explain the behavior of a student proving a
theorem in Eucledian geometry the initial and boundary conditions would
have to include the axioms, rules of inference, and some other basic data
about the subject of Eucledian geometry. The same requirements must be
met if this theory is to be used to explain the behavior of a subject
proving a theorem in mathematical logic, trigonometry, or solving other
types of problems that are stated in a particular form.[5]

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[4] For a more detailed description of the structure of the General
Problem Solver and of the empirical tests that it has undergone see
A. Newell, J. C. Shaw, and H. A. Simon, "A General Problem Solving Program
for a Computer," op. cit., and A. Newell and H. A. Simon, "Simulation of
Human Thought," op. cit.

[5] Since the General Problem Solver reasons in terms of means ends
analysis, the problems must be in a form that is suitable to this sort
of reasoning process. For a more detailed analysis see the previous
references.

Thus, it is clear that the decision processes contained in this theory are reasonably independent of the content of the subject matter of the particular problem at hand. From these results there is a certain amount of evidence that suggests that humans use roughly similar sets of decision processes to solve a wide variety of problems.

A Some Independent Processes

The evidence from this discussion appears to suggest the following points about the consumer's decision processes: (a) the consumer's main decision processes should be roughly the same no matter what category of commodities are being selected from at any one period of time, (b) these decision processes should be constructed so that they are largely independent of the subject matter of any one category of commodities, and (c) some special decision processes will be needed for each category of commodities to allow the basic set of decision process to be applied to the particular decisions that occur only within each of the separate categories. Having arrived at this set of conclusions we shall now move on the examine some of the main decision processes that could be constructed so that they would be largely independent of the subject matter of any one commodity category.

1. The first main decision process that could be constructed in this manner is the consumer's decision to buy a particular set of commodities with cash or cash equivalents, or by managing to pay for them by a set of monthly payments. This decision process may not appear to be a particularly

important one of we take the case of a consumer deciding whether or not

to buy some minor durable good. But, if properly constructed there does

not seem to be any à priori reason why this decision process could not

encompass such decisions as: (a) the decision whether to rent or buy

housing accommodation. (In the event that the consumer decides to own

his own dwelling unit this process could include the decision on the size

of the mortgage payments that could be tolerated. Consequently, it would

include a decision on roughly how expensive a dwelling unit the consumer

would be willing to purchase.) (b) the decision whether to purchase other

durables for cash or whether to spread the payments for them over a period

of time. (As in the previous example, this decision process would include

some notion of the upper limit of the size of these periodic payments that

the consumer would be willing to pay), and (c) many of the remaining rent

or buy decisions that a consumer periodically has to make a decision about,

e.g. the "go-not-and-pay-later" plans for vacations, the monthly payment

for insurance premiums against various contingencies, etc. This is not

to say that all these decisions can be repreduced by one decision process.

But rather that they all have one essential element in common—that is,

whether there are allocated funds available to cover the purchase of the

commodity in question; and if not, whether by paying for the commodity

over a period of time the periodic payments will be low enough so that

they can be paid for by the funds that have already been allocated

to that commodity category. In other words, we are essentially suggesting

that there is still another major allocative process that must be taken
into account after a consumer has decided on how to allocate his total
income among the various categories of commodities. Further, we are
suggesting that this second allocative process will be largely independent
of the contents of each category. Also that its main purpose will be to
decide by what method of payment the commodities in question are to be
purchased, if the total outflow of funds is not to exceed the total amount
of funds previously allocated to this commodity category. While this
allocative process may differ slightly between particular individuals we
are also suggesting that its principal components will be the same, and
that the essential parts of this procedure could be represented by one
set of decision processes.

For example, if we refer once again to the theory of trust investment,
we can see how the analogous situation could be handled in that context.
As previously mentioned, the theory of trust investment was only concerned
with explaining the decision behavior of a trust investor as it pertained
to the selection of common stocks for particular trust accounts. Also we
have noted that the consumer's decision to allocate his total income among
the various commodity categories was analogous to the trust investor's
decision to allocate the total funds available for investment among the
various categories of securities. What we are now suggesting is that the
decision on how to allocate the funds within each category is essentially
the same for all categories. This is not to say that the decision process

in the theory of trust investment which governs the selection of common
stocks would be the identical to the processes which govern the selection
of bonds of preferred stocks. But rather that these selection procedures
can be represented by one main decision process that allocates the funds
between the different common stocks, preferred stocks, and bonds.

In the theory of trust investment there is a set of decision processes
which govern the process that identifics the particular set of securities
from which a portfolio is selected. But independent of the particular
trust account under consideration, there is only one decision procedure
that enables the theory to allocate the available funds among the
securities that are considered to be appropriate for a specified account.
Hence, we are suggesting that if the theory encompassed the selection of
bonds and preferred stocks as well, then there still would need to be only
one principal decision procedure which determined how the funds available
for each category were to be allocated among the available securities.
While this hypothesis was not tested the evidence[6] suggests that such a
hypothesis might well be confirmed if it were submitted to a series of
empirical tests.

Despite the fact that this evidence does not offer a great deal of
support for our hypothesis, it is sufficient to suggest the possible

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6/ Op. cit., Chapters 6 and 7.

existence of such a decision process. And it must be left to empirical

research to determine whether it can be corroborated or not. Also, until

some further empirical investigations are carried out, there does not seem

to be any reason to suggest that a consumer should behave in a radically

different fashion from that of a trust investor. Accordingly, unless

some evidence is discovered that refutes our hypothesis it would appear

that the allocation process could be represented by a set of decision

processes that was sufficient to account for the allocative procedure within

each of the various categories.

2. Another major decision procedure that could be constructed so

that it was independent of the content of a particular category is the

process that permits the consumer to select one set of commodities from

the available alternatives. This is not to say that the set of processes

that would allow a consumer to select a collection of groceries should be

the same as the set of decision procedures that would allow him to decide

which new clothes he should buy. But rather it is the procedure by which

these decisions are reached that represents the common element among these

many particular decisions. In micro-economic theory this decision procedure

is stated in terms of the maximization of a given criterion function. Now

a maximizing decision process implies, among other things, that all the

available alternatives must be compared against each other. Also that after

these comparisons are made the consumer then selects the commodity or

set of commodities which yield him the highest utility--that is, are the

most preferred or in some definable way rank the highest on the comparison
scale. Whether a consumer does in fact employ a maximizing decision
procedure or not is a question that can only be settled by empirical
research. But what we are suggesting is, that we can also assume there
is one principal set of processes which a consumer employs in order to
decide on the particular set of commodities to purchase. That this
set of decision processes should turn out to be consistent with a maximizing
hypothesis is something, as we have just noted, which can only be determined
by empirical research. However, at present the available evidence[7] suggests
that this decision procedure would be composed of the following two components:

First of all there would be a set of decision processes that enabled
the consumer to rank order, or in some other manner compare, the alternatives
that are available within a particular class or subclass of commodities.
This does not imply that the criteria by which each class or sub-class of
commodities are compared are to remain the same for all classes and
categories of commodities. On the contrary, one would expect a different
set of criteria to apply to each sub-class of commodities. For example,
one would not expect the criteria employed by a consumer to select his
groceries to be the same as those employed when he selects a new
refrigerator. The point at issue though is not whether a particular set
of criteria are employed to rank order a particular sub-class of commodities.

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[7] For an empirical exploration of some of the implications of these
processes see: J. Feldman, op. cit., and G.P.E. Clarkson, op. cit.
For further more general, evidence see: R. M. Cyert, H. A. Simon, and
D. B. Trow, "Observation of a Business Decision," Journal of Business
Vol. 29, 1956, pp. 237-248; and the cases cited in R. M. Cyert and
J. G. March, The Behavioral Theory of the Firm, op. cit.

But rather that the process by which these criteria are employed will remain the same independent of the class or sub-class of commodities that is being considered. For example, in the theory of trust investment a different set of criteria are employed for each of the investment policies to ensure that securities are selected that are consistent with the particular objectives of each trust account, e.g. growth, income, and mixtures of these two goals. But in order to make the desired selections only one basic set of decision processes is employed. Consequently, we are suggesting that the consumer's selection procedure can be represented by one set of decision processes which are constructed so as to allow for the inclusion of particular sets of criteria which in turn depend on the class of commodities currently under consideration.

The second component of this decision procedure would consist of a set of processes that determine the manner in which possible alternatives are to be appraised for selection. If we had a maximizing decision procedure all the available alternatives would have to be searched and examined in order to ensure that the "best" one was selected. However, in our case we are trying to construct the outlines of a theory that would be sufficient to reproduce observed behavior. The evidence that exists[8]

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[8] For examples of this behavior in individuals see the references cited in the previous footnote as well as: A. Newell, J. C. Shaw, and H. A. Simon, "Empirical Explorations... ." op. cit.

suggests that individuals do not exhaustively search and examine all the available alternatives. On the contrary, it appears that individuals search among the alternatives until one is found that meets the specified criteria. At this point the search process stops and the satisfactory alternative is selected.

For example, in the theory of trust investment securities are searched and examined until a list of common stocks is created that are suitable for the investment policy of the trust account under consideration. These stocks are classified by industry. Also there is a diversification rule that restricts purchases to no more than one security per industry. As a result, the theory must provide some procedures for selecting the particular participation in each industry. Now a decision rule that required all the securities within each industry to be examined before a selection was made would generate behavior patterns that are distinctly different from those produced by a decision rule that started its search at the top of a list and stopped the minute a security was found that met the desired criteria. In the empirical tests, it was the behavior generated by the latter decision rule that more closely matched the observed behavior of the trust investor. Similar evidence is provided in the empirical research noted in the previous footnote. Hence, it would appear that we should adopt for our theory of behavior a decision procedure that allows the consumer to search among the available commodities until one is found that meets the desired criteria for that type or sub-class of commodities.

3.   A further major requirement of our theory would be a set of
decision processes that allows the theory to adjust its selections in
accordance with some expectations about the future behavior of prices,
and other variables that are considered important. Once again it is
suggested that the basic set of processes that accounts for the consumer's
expectations should be independent of the content of a particular commodity
category--that is, the chief mechanisms that incorporate and manipulate
expectations should be the same no matter what the expectations refer to.
In this case the evidence suggests[9/] that expectations can be accounted
for by decision processes that search for and recognize patterns among
the given data. Although the evidence on this point is somewhat sketchy,
it appears that one way in which patterns can be built and recognized is
to employ the patterns created by past data as the basis from which to in-
terpret the current and the expected movements of a variable.

For example, if the pattern created by the movements of the prices
of a particular sub-class of commodities has been uniformly constant over
the relevant period in the past a sudden rise in these prices would
probably be interpreted by this pattern recognizing process as some

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9/   For some examples of this pattern-recognizing process see: Bruner,
Goodnow and Austin, A Study in Thinking, Wiley, 1956; and
J. Feldman, op. cit.

temporary phenomena which will soon disappear. If, however, the higher
price level is maintained for a period of time, and there are no indications
that the level will go any lower in the immediate future, then the pattern
recognizing process would adjust itself to the new level of prices.
Decisions about future price movements would then be made in terms of the
new price level. While this is by no means the only type of pattern-
recognition process that could be employed, the only way to determine
which one should be used is to examine the behavior generated by these
processes and see which one comes the closest to matching the observed
behavior of consumers. Once a set of decision processes has been
constructed that is sufficient to account for the observed behavior, this
hypothesis should then be used as the basis for the decision procedures
that are to account for the effect of expectations on the consumer's
behavior in each category of commodities.

4. A fourth, and perhaps the last, major component that this
theory would require is a set of processes that resolved the various
conflicting situations that might arise. For example, in any particular
time period the amount of funds available for expenditure within a
given category of commodities may not be sufficient to cover either the
expense of the proposed purchase or the payments that have already been
incurred. One method for settling such conflicts before they arise
is to include a decision rule that does not allow the total expenditure
within each category to exceed the total amount of funds that have previously

been allo ted for it. If this allocation procedure is carried out
each week or month, then when the funds of one category are exhausted
the theory would prohibit further purchase until a new allocation was
made at the beginning of the next period. While this decision rule may
well generate results that are consistent with observed behavior, it is
possible that a decision rule which allows available funds to be inter-
changed between categories might generate behavior patterns that were more
consistent with the observed data. In either event a decision rule of
this sort is clearly required. And it is up to empirical investigations
to discover which one best suits the purposes at hand.

2. Interpreting the Proposed Theory

Having outlined some of the major decision processes that an "ideal"
model of a consumer's decision-making behavior would require, we shall
now examine the ways in which this "ideal" theory could be employed to
extablish an explanation of a particular individual's behavior. As we
have noted on several occasions, the only way in which a theory repre-
senting an "ideal" case can be employed in an explanation of a particular
event is by providing a set of interpretive rules that allow the general
model to be related to the data of the particular case. In the case of
our theory of decision-making behavior these interpretive rules would
consist of a collection of statements that prescribed the ways in which
the particular tastes, preferences, and other parameter values of the

individual are to be incorporated into the decision processes. To
clarify how these interpretive rules might be employed we shall examine
the main decision mechanisms outlined in the previous section and shall
attempt to point out the various factors that should be included if the
theory is to be used to account for the behavior of a particular individual.

For the first decision process--that is, the procedure that allocates
the consumer's total income among the various categories of commodities--
the interpretive rules appear to be readily identifiable. The decision
process itself was constructed to allow for the inclusion of particular
parameter values. Thus, it would appear that this decision rule could
be empirically interpreted by observing the proportions of total income
that a consumer allocates to each category and placing these parameter
values directly into the decision process. Clearly this would allow our
decision rule to account for this consumer's allocative procedure up
to that moment when he altered his allocations. While many people may
continue to employ one set of allocative procedures with admirable
constancy, an inflexible decision rule would prevent the theory from
responding to changes in total income with disproportionate changes in
the allocations. Hence it would appear that some set of adaptive
mechanisms should be included that allows the proportions of the total
income spent on various commodity categories to change as the total
income rises or falls. One possibility is to include in this decision
procedure a set of our pattern recognition processes. If this type of

process was employed a sudden rise in income could be treated as though

it were an unearned bonus to be allocated to some special purchase.[10]

On the other hand a steady rise in income would be treated as the normal

pattern to be expected and the allocative procedure would carry on it

the same manner as before. Whichever set of decision processes is

selected the parameter values can be determined from a detailed study of

consumer behavior. Therefore, for this decision process the interpretive

rules would consist of a set of statements that described how the observed

allocative behavior of a particular consumer was to be reflected by a

particular set of parameter values.

Although the principal allocative process that we have just discussed

does not seem to present too many obstacles to empirical interpretation,

the second allocative procedure--namely, the decision procedure that

decides whether to pay for purchases out of immediate income or by

several payments over a period of time--would require more extensive

empirical investigation. It has been suggested that the allocative

procedure in each category of commodities could be represented by one

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10/ Such behavior would not be inconsistent with the "permanent income
     hypothesis" of M. Friedman, A Theory of the Consumption Function, National
     Bureau of Economic Research, Princeton, 1957, or the "permanent wealth"
     hypothesis of F. Modigliani and A. Ando, "The 'Permanent Income' and the
     'Life Cycle' Hypotheses of Saving Behavior," in I. Friend and R. Jones (ed.)
     Proceedings on the Conference on Consumption and Saving, University of
     Pennsylvania, Vol. II, 1960, pp. 49-174.

basic decision process. While this may in fact turn out to be the case the decision of whether to "pay now or over a period of time" will in part depend on various factors, e.g. the interest rate, the amount of credit already out-standing, the full cost of the commodity, etc., which can be expected to vary from one period to the next. Hence, not only must the decision process itself make allowances for the inclusion of these variables, but the interpretive rules must specify a set of procedures whereby the appropriate parameter values may be empirically determined. Unfortunately this part of the decision-making process has not been sufficiently explored to suggest in any detail the types of interpretive rules that might be required. But one possibility is a decision rule that discovers whether a further set of time payments can be allowed by evaluating whether the total amount of outstanding credit exceeds a certain proportion of total income. While this particular decision rule may or may not be corroborated by empirical research the interpretation of such a rule would not present any serious obstacles.

In a similar manner interpretive rules would have to be supplied for the remaining decision processes. For example, the relevant attributes of various classes and sub-classes of commodities would have to be observed and noted so that the theory's selection procedures could compare the available commodities on the same basis as that of the particular consumer under investigation. Also some criteria would have to be incorporated

into the theory to enable it to recognize when a particular commodity
was considered to be satisfactory. Presumably some of these criteria
would vary with the different classes of commodities and we might be led
to expect a rather complex set of criteria for each class and category.
But, if the selection procedures of the theory of trust investment are at
all representative of human decision-making processes, these selection
procedures should neither be highly complex nor differ too much from
one class of commodities to another. The same comments should also
apply to the sets of decision processes that account for the effects of
expectations on purchasing decisions. While each category of commodities
may require its own set of pattern recognition processes it is somewhat
unlikely that they will differ in any radical way. Some variables may
be more important for one class of commodities than another. But the
total number of important variables for any class of commodities will
not be large. Thus, they should not be particularly difficult either to
identify or interpret.

While the answers to these problems, and hence the specification of
these interpretive rules, can only be obtained by empirical research, it
would be somewhat premature to conclude that the task was too involved
or complex to be successfully undertaken. In discussing the construction
of this theory we have repeatedly noted the research on human decision-
making behavior that is already underway. Also we have freely employed
the evidence from some of these studies to suggest various ways in which

the proposed theory can be simplified and empirically interpreted.
Further, since several of the reported theories have survived a series
of direct empirical tests, there is a certain amount of evidence to suggest
that a detailed theory of a consumer's decision behavior can in fact be
constructed and tested. Therefore, although a considerable amount of
research still needs to be undertaken there does not appear to be any
prima facie reason why part of this research should not result in a
testable theory of consumer behavior.

3. On Reducing the Theory of Demand

In the previous section we have outlined in some detail the
possible structure and content of a testable theory of consumer
decision-making behavior. It is now time to examine more closely the
problems involved in determining how the theories of utility and demand
could be reduced to such a theory of individual decision-making behavior.

The proof that one theory can be reduced to another is a problem that
can only be settled by empirical research. It is only after a theory has
been constructed that it can be effectively demonstrated that the laws
and postulates of one theory can in fact be deduced from another. But,
we have suggested that one way of turning the theories of utility and
demand into empirically testable theories is to develop a testable theory
of consumer decision behavior to which these theories can be reduced.
Therefore, it is still part of our task to point out the manner in which

this reduction process might be shown to have taken place. Although we
cannot demonstrate that this reduction has been accomplished, we are at
least able to examine some of the ways in which such a reduction could
take place.

If we are to be able to demonstrate that a micro-reduction of the theory
of demand has been effected, then we clearly must be able to show that
the reduction of the theory of utility has also been accomplished.
But, if we can show how the theory of utility could be reduced, then it
would follow that the theory of demand would have been similarly reduced.
To be able to micro-reduce the theory of utility implies that the postulates
of utility theory must be derivable from the reducing theory. Accordingly,
if we can demonstrate that it would be possible to derive the postulates
of utility theory from our theory of consumer decision-making behavior,
then it would follow that the theories of utility and demand had been
effectively reduced. Our task, then, is to examine the theory of
consumer behavior as outlined in the previous sections in order to
ascertain whether it would be possible to deduce from this theory the
basic postulates of utility theory. However, before we can proceed with
this investigation we must first be sure that we understand not only
what the theory of utility represents but also how its postulates may be
interpreted.

As noted in Chapter III, the theory of utility is a theory of decision-
making behavior and can be taken to represent how the "ideal" consumer

selects the bundle of commodities that he desires from all of the

alternatives that confront him. But, in Chapters IV and V it was

pointed out that this theory lacked sufficient empirical interpretation

to be subjected to a series of empirical tests. One of the difficulties

that was encountered was the fact that it is not possible, except in a

few simplified cases[11], to specify beforehand the decision-making behavior

that the consumer must exhibit if it is to be consistent with the basic

postulates. But now that we have, at least in outline form, a theory

that proposes to account for a consumer's choice behavior in terms of

his decision-mkaing processes. It would appear that we have a theory that

will specify in some detail the decision behavior that the consumer must

exhibit if he is to behave in a manner that is consistent with out theory.

Thus, if we can accept for the moment the hypothesis that we can indeed

construct and test our theory, then we can examine the behavior that is

generated by the theory to see whether it is in fact consistent with the

basic postulates of utility theory. This is not to say that the postulates

of utility theory would necessarily be directly testable in this manner.

But this approach does suggest a possible way in which they might be tested.

Consider, for example, the first three postulates as noted in

Chapter III. The first requires that the consumer must be able to state

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11/ For example, the binary choice experiment, see pp

for all possible pairs of alternatives A and B whether he prefers A to B,
B to A, or whether he is indifferent between them. Now our theory of
consumer behavior does not necessarily examine all possible alternatives
before it applies it selection procedures. Instead it only examines
some of those alternatives that are available to it at the time the decision
is to be made. However, the theory of revealed preference has shown
that it is not crucial to the theory of utility that all possible
alternatives be examined. Thus, if we examine only those alternatives
that are considered by our theory at one period of time, we can still
check to see whether the preferences exhibited by the theory are
consistent with a weak ordering of the alternatives. Now the second and
third postulates require the consumer to be consistent in his choices and
to make up his mind whether for a particular pair of alternatives A and B
he prefers A to B, B to A, or is indifferent between them. Once again the
decision behavior generated by our theory could be examined to ascertain
whether it was consistent with these postulates or not.

For example, the processes that order and make selections from a
certain class of commodities can be inspected to see whether the
selections that they generate corroborate these two postulates of
utility theory. Any changes in these selections that are due to a
change in expectations could also be inspected for consistency. Hence,
although we cannot demonstrate that these postulates could be derived
directly from our proposed theory it does appear that it would be

possible to subject them to a series of indirect empirical tests.

The testing of the fourth postulate--that is whether the consumer always selects that set of commodities that he most prefers--would, however, appear to present some rather special difficulties. Earlier in this chapter it was noted that a maximizing decision criterion implies that the selection procedures must examine all the available alternatives, so that it can ensure that the "best" one has been selected. In our proposed theory of consumer behavior the selection procedure stops as soon as an alternative is discovered that meets the appropriate criteria. Under this decision rule it is quite possible to accept the very first alternative that is examined. If the behavior generated by this decision function is consistent with the observed behavior of consumers, then this evidence would not appear to be consistent with that required by the fourth postulate.[12] However, to be able to corroborate or disconfirm the maximizing postulate one would have to be able to show that the alternative selected by our theory was or was not the "best" one that could have been selected from those available at the time. This would imply that the selection process contained criteria that were sufficient

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12/ For a more detailed comparison of the behavior generated by a decision function of this type and a maximizing decision criterion see: G.P.E. Clarkson, op. cit., Chapter 8; and J. Feldman, op. cit.

to identify the "best" commodity from those that were available. But
the proposed selection procedures only reflect the adequacy of the
alternatives to meet a set of criteria that are adjusted to meet changing
expectations. And there does not seen to be any direct way of deciding
whether the selected alternatives are "optimal" or not. Manifestly,
this is a question that can only, at best, be settled by empirical research.
If it should turn out that a maximizing decision criterion is not
consistent with the observed behavior then either the fourth postulate
must be relaxed[13/], or our proposed micro-reduction of the theories of
utility and demand cannot take place. If the latter alternative is
chosen we are back to where we began and are faced with an untestable
theory of demand. If the former alternative is accepted and the consequences
explored then the evidence strongly suggests that a testable, revised
theory of demand can indeed be developed.[14/]

13/ For an example of a rational theory of choice that does not employ
a maximizing decision criterion see: H. A. Simon, "A Behavioral
Model of Rational Choice," Quarterly Journal of Economics, Vol. 69,
Feb., 1955 (reprinted in H. A. Simon, Models of Man, 1957, pp. 241-260).

14/ See, for example, the evidence that is presented to support the
development of a more comprehensive and testable theory of the firm
that is contained in: R. M. Cyert and J. G. March, The Behavioral Theory
of the Firm, op. cit.

CHAPTER IX

SUMMARY AND CONCLUSIONS

At the beginning of this essay we observed that the theories of
economics are noted for their lack of success in predicting the course
of economic events. Also it was pointed out that is has frequently
been argued that the problems involved in the development and testing
of economic theory are essentially different from those encountered in
the physical sciences. It has been the purpose of this study to dispute
and refute this point of view. In particular it has been our primary aim
to demonstrate that it is within the theories of economics themselves,
and not within the content of the subject matter itself, that the source
of the difficulty lies.

To demonstrate the validity of this claim we pointed out that if it
could be shown that the theories of economics could not be subjected to
a process of refutation by empirical test, then it would follow that
these theories have been constructed in a manner that precledes the
possibility of generating successful predictions. While we have by no
means demonstrated the validity of this claim for all of economic theories
we elected to present the evidence for our claim in terms of one of its
acknowledged goals--namely, the description and prediction of the
behavior of economic man. Consequently, in the first part of this essay
it has been our object to investigate and establish the proposition that
the micro-economic theory of consumer behavior (the theory of demand) is

not refutable by empirical test.

Although it is usually more difficult to substantiate a negative
rather than a positive claim we saw from the analysis of deductive systems
that a theory could not be refuted by empirical test if it is
constructed in such a fashion that: (a) all its hypotheses and concepts
are stated in terms of theoretical concepts, or, (b) not one of its basic
postulates or deduced hypohteses can be directly refuted by empirical test.
Hence, our first task was to examine the terms and concepts employed in
the theory of demand in order to ascertain the extent of their empirical
content. This analysis was carried out by examining both the way in
which the concepts are introduced into the theory and the way in which
they are related to one another. By this analysis it was evinced that
the concepts and terms of the theory of demand depended for their empirical
content on the four basic postulates of utility theory. This is not to
say that there are no other means of introducing empirical content into
these concepts. But rather that the remaining sources of empirical content
could be employed only if these basic postulates were empirically
confirmed. It was concluded, therefore, that the concepts of the theory
of demand were open to empirical analysis if and only if the basic postulates
themselves could be confirmed by empirical test.

Once the conepts had been examined by themselves it was then necessary
to inspect both the basic postulates and the deduced hypotheses. The object
was to determine whether either one or both of these sets of hypohtesized
expressions could be corroborated by empirical test. If either set of
statements could pass this test then it would follow that the concepts of

the theory would have some empirical content. And, as a result the
theory itself could be confirmed or disconfirmed by empirical test. But,
an examination of the function of general laws or hypotheses in the
scientific explanation of observable events led us to the conclusion that
neither the basic postulates nor the hypothesized expressions had sufficient
empirical interpretation to permit them to be disconfirmed by empirical
test. Despite the fact that empirical evidence can be found that tends
to support these hypohteses it was demonstrated that it would not be possible
to employ any of these observations to disconfirm these hypotheses.

In our discussion of deductive systems it was noted that a "true"
consequent can be used to support a "false" relation just as readily as
a "true" one. Thus, unless it is possible, in principle, to disconfirm
these hypotheses we have no means of determining whether they have been
confirmed or not.

Since the hypothesized statements cannot be disconfirmed it follows
that the explanations of consumer behavior offered by the theory of
demand must fit an ex post facto explanatory schema. In other words, the
theoretical structure of the theory of demand is such that it is an
effective tool for analyzing and rationalizing the occurrence of an event
after, but not before, it has occurred. Further, if the theory of demand
is unable to establish a scientific explanation of observed consumer
behavior, then it is not possible to employ this theory to generate

successful predictions. By demonstrating that the theory of demand is
an uninterpreted theoretical structure we established the first part of
our thesis--namely, that the reason for the absence of predictability in
micro-economics lies within the theory of demand itself, and not within
some special properties of the subject matter.

Once it has been shown that the theory of demand cannot be refuted
by empirical test the question is immediately raised of how to rescue
the theory from beyond the pale of empirical science. From our analysis
it appears that this problem would be resolved if a set of postulates were
constructed that were both directly refutable by empirical test and
formulated in such a manner that they formed an empirical basis for the
theory of demand. Although it is quite unlikely that there is only one
solution to this dilemma the theory of reduction suggests one possible
answer. In brief, this theory suggests that an answer can be found by
developing a testable theory of individual consumer behavior to which the
theory of demand can be micro-reduced. In other words, the empirical basis
of the theory of demand can possible be found in a testable theory of
individual decision-making behavior.

In the last part of this essay a solution to the dilemma is proposed
by developing the outlines of a theory of individual consumer behavior.
This theory is designed to serve as a basis for the micro-reduction of the
theory of demand to observable decision-making behavior. While the actual

construction and testing of such a micro-reduction theory can only be
accomplished by empirical research, recent developments in the theory of
human problem solving were examined to discover whether theories of
decision-making could be corroborated by empirical test. Despite the
fact that several of these theories are concerned only with human
problem solving and not with economics at all, it was evinced that
hypotheses concerning decision-making behavior could be confirmed in a
wide variety of empirical contexts. If it is possible to construct a
testable theory of human problem solving, then it follows that it is
possible to construct a testable theory of individual consumer behavior.
Clearly, the successful reduction of the theory of demand to a testable
theory of individual decision-making behavior can only be accomplished by
empirical research. But it has been our object to point out that a
micro-reduction of the theory of demand is both theoretically and
empirically justified.

Once the theory of demand is successfully reduced it is clear that
the more common objections to developing testable economic theories will
have been shown to be false. For example, economists, along with many
other social scientists, have often stated that the inability to conduct
controlled experiments is one of the major obstacles preventing the
discovery and development of testable theories. But, if an empirical basis
for existing theoretical structures is sought by developing theories of

individual behavior the problem of running controlled experiments almost
entirely disappears. From the evidence adduced in support of our theory
of individual consumer behavior it is apparent that human decision-making
can be described and incorporated into a testable theory of economic
behavior. (It bears repeating that these theories have been developed by
employing the theory of human problem solving and the technique of computer
simulation. And the technique of simulation allows these theories to be
repeatedly tested and amended to fit a wide variety of observed behavior.)
Now a particular theory may only be concerned with the behavior of an
individual consumer under a particular set of circumstances. But if the
theory is empirically testable, then it can be tested against repeated
observations of the same consumers. While we have no desire to minimize
the difficulties that will be encountered in such a testing program, the
point at issue is that the theory can be subjected to such a testing process.
Therefore, even though controlled experiments on a grand scale will
probably always present enormous difficulties, the mere existence of a
theory that can be subjected to a rigorous series of empirical tests refutes
the hypothesis that is not possible to test an economic theory by such
experimental procedures.

The possibility of reducing the theory of demand to a testable
theory of individual consumer behavior raises a further and more important
question--namely, that of the direction of future research in micro-economics.

Since th theory of demand and the theory of utility serve as the basis for a large part of micro-economic theory, the results of our analysis imply that a large part of micro-economics is also not refutable by empirical test. While this is not the first time that this conclusion has been voiced the existence of a possible solution to the dilemma suggests that more attention should be paid to the implications generated by this state of affairs.

Traditionally economists have been more interested in developing normative rather than positive theories. But it is clear that it is the positive theories that must provide the scientific basis for policy prescriptions. If the theories of micro-economics cannot be subjected to empirical test then it follows that their normative counter parts must also be largely devoid of empirical content. Indeed, before it is possible to employ normative theories to generate empirically meaningful policies, the positive theories upon which these normative theories are based must be empirically confirmed. Therefore, if the chief goal of the economist is to be served, then a great deal more attention must be paid to developing and testing the positive theories of micro-economics.

In this essay, our principal objective has been to isolate and identify the reasons for the lack of predictive success that is so frequently a part of economic theories. We have been led by our analysis to propose a solution to this dilemma. Although our solution has yet to

be corroborated by empirical research it is clear from our analysis that the problems of developing and testing micro-economic theory need no longer be considered to be different from those encountered in the physical sciences. Also, and perhaps what is more important, we are able to conclude that it is possible to develop a body of micro-economic theory that has the same predictive and explanatory power as is enjoyed by the physical sciences.

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